Nutritional Evaluation of Available Feed Resources And Comparative Study of Free Range Grazing Verses Managed Feeding System in Bundelkhand Region

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By

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2003

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CERTIFICATE

This is to certify that the Thesis entitled "**Nutritional evaluation of available feed resources and comparative study of free range grazing verses managed feeding system in Bundelkhand region** " submitted for the award of Ph.D. degree in Animal Husbandry and Dairying, Faculty of Agriculture by Prakash Narayan Dwivedi embodies the results of the bonafied research work carried out by him under my guidance and supervision. No part of the study reported here has so far been submitted anywhere for publication of anyother degree or diploma.

Mr. Prakash Narayan Dwivedi has worked under me more then the period required under the Ph.D. degree ordinance 7 of the university and has put in the required attendance in the department during the period.

Place: Rath (Hamirpur)
Date: 21.08.03

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Guide /Supervisor

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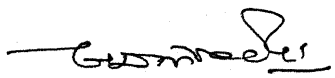

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List of Tables

List of Figures

CHAPTER I

INTRODUCTION

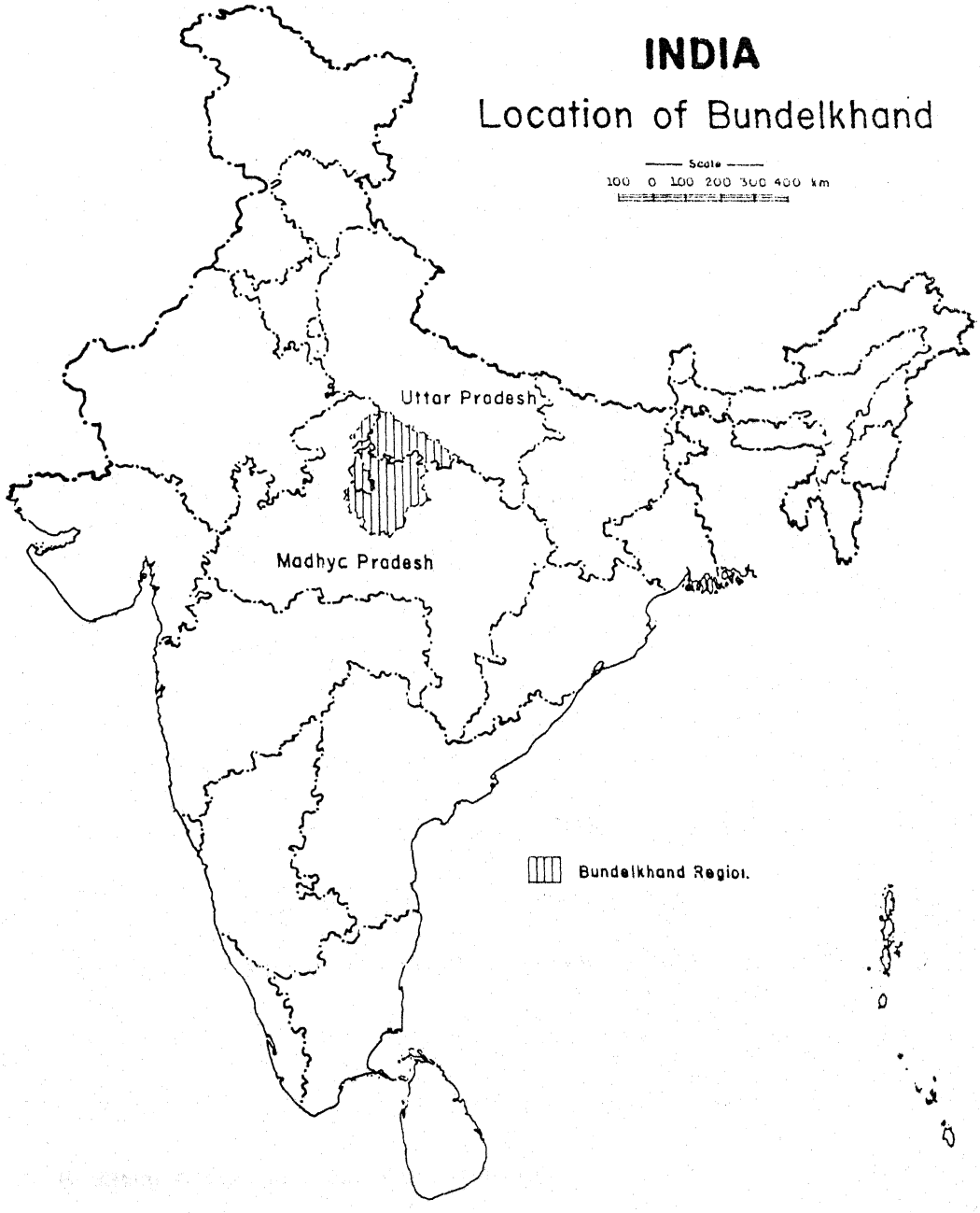
India has a wide range of agro-climatic diversity. The resources, constraints and technological advancement may differ from one region to other. Therefore research focused to specific region may be the appropriate option to address the issues related to the livestock farmers of that region. The study area, i.e. Bundelkhand region, covers 71,618 km^2 in the Central part of Northern India (Fig.1), crosses two states, 7 districts being in Uttar Pradesh (U.P.) and 6 in Madhya Pradesh (M.P.). Although it has no administrative function, the 12.45 million people (1991 census) who live in the region having a distinct cultural identity and speak their own dialect of Hindi. Bundelkhand is characterized by an undulating and rugged topography, limited underground water resources, high proportion of wasteland, high summer temperature, erratic rainfall in a short monsoon period and low fertile soil. Despite all these difficulties, 67% of the working population depend on agricultural activities for their income, cultivating food crops such as cereals, pulses and oil seeds and raising livestock, mainly cattle, buffaloes, goats and sheep. The low productivity of soils and the unreliable rains have encouraged the majority of population to keep animals as an

insurance against crop failure, a particular risk during drought years, occurring normally once in four year. Animals provides milk for consumption and sale, dung for fuel and manure and power for agricultural operations, they have additional benefits of giving owner an increased status within the community and are often used to sale to provide cash in emergency.

Fodder shortage exists across most part of the region. Negligible quantities of fodder are cultivated in the area (only 1% of the land) and the animal fed on the crop residues which constitute the main source of roughage but even this is far from enough to meet the requirements. Such shortage means that the majority of farmers have little option except to leave their animals for free grazing, mainly in forest areas, on wastelands or the residues which left in the field after crops harvesting.

In year 1985 there were 5141456, 1490511, 1699874, 361833 cattle, buffalo, goat and sheep respectively. Buffalo and goats were more in U.P. part while cattle and sheep were more in M.P. part of the region. In 2001 the populations of cattle, buffalo, goat and sheep have changed to 4327750, 1764373, 1837052 and 408269 respectively. In Bundelkhand there are only about 0.25% crossbred cattle. During 2001, it was found that the cattle population was more in Chhatarpur, Sagar, Lalitpur and Hamirpur districts. The buffalo population was more in Banda, Jalaun and Chhatarpur. The goat population is more in Chhatarpur, Banda, Hamirpur and Jhansi district. The sheep population was more in Chhatarpur, Tikamgarh, Jhansi and Hamirpur.

Fig. 1


INDIA
Location of Bundelkhand
Scale
100 0 100 200 300 400 km
Uttar Pradesh
Madhyc Pradesh
Bundelkhand Regiot.

The recommended maximum animal density for the type of land found in the region, was 0.78 adult cattle unit/ha (Tyagi, 1997). Whereas huge number of animals existing in Bundelkhand (1.16 animals/ha). About 1% land is spared for cultivated fodder making the animals almost dependent on crop residues, which are in deficit. This compels farmers for free range grazing of forest areas, on wastelands or the residues, which remains in the field after harvesting crops. These figures clearly indicate that area is over grazed and consequence of this high animal pressure has led to widespread deforestation and grassland degradation in the region (Gomez *et al.* 1998). Few farmers having sufficient fodder supply, adopted managed feeding system (which includes stall feeding as well as rotational grazing).

In Bundelkhand, among 26 recognized breeds of cattle only *Kenkatha* breed is found. Others are non descriptive and there is small population of crossbreds, *Haryana* and *Tharparkar* breed. The home tract of *Kenkatha* breed is Ken basin around Banda district. The main reasons for its insecurity are crossbreeding with non-descript breeds, inbreeding and loss of natural grasslands. *Kenkatha* is good breed for draught purpose. *Bhadawari* breed of buffalo is found in Bundelkhand. However, *Murrah* is increasing in number along with other *desi* buffalo breed in Bundelkhand. *Bhadawari* is well known for its high fat percent(10-14) of their milk, but because of their low milk yield (600-1000 kg), they are being upgraded with *Murrah*. Among a total of 40 sheep breeds in India, *Muzzaffarnagari* and *Jalauni* breed of sheep are found in Bundelkhand.

Mainly landless and small farmers rear goats. The local goat breed "*Bundelkhandi*" is popular in most of the villages, although in some villages crossbreed and *Barberi* goats are there. Goat farming is mainly practiced in villages away from cities. Most of the farmers sold their goats for meat. Farmers considered goat farming as less risk enterprise. There is traditional system of rearing. Goats graze on community land and degraded forest along with tree leaves browsing. The kidding seasons are October to December and April to May.

The housing system and management are not proper and do not provide conducive microclimate to exhibit the production efficiency. The protection from the adverse climate especially during dry summer is not adequate. The tropical stress management practices are not followed properly. The management of animals during heifer stage is very much ignored resulting in adult animal of poor potential.

The vegetation of grazinglands of Bundelkhand region comprising Vindhyan plateau and hilly tracts, propagate grasses such as *Heteropogon sp., Themeda sp., Digitaria sp., Iseilema sp., Dichanthium sp., Sehima sp.* etc.

Free grazing system or *Anna Pratha*, in which animals are let loose in the open harvested fields after the harvesting of *Rabi* crops allowed free grazing in summer and part of rainy season. Most of the animals remain underfed and this practice result in low livestock productivity in the region. Free range grazing system adversely affect the breed improvement programme because open free grazing herds are mainly covered by local bulls and produce undiscript and low producing off springs. Farmers kept their land fellow during *Kharif* in some part of the region and

Anna pratha is one of the reason for not growing crops in the *Kharif*. Comparison of free range grazing and managed feeding (in which controlled grazing and supplementary stall feeding is followed) may focus on problems and opportunities of both the system for farmers benefit and sustainable livestock production.

There are some reasons or conditions which force the free range grazing and stall-feeding in Bundelkhand. The villages have high proximity to forests, wastelands and fallow lands had a high proportion of free range grazing. The small holders and the landless, even in irrigated areas, practice free range grazing. In high cropping intensity villages, where crop residue production is more, there is stall feeding. Reverses is true for villages with low cropping intensity. Villages with access to the milk and fodder markets had a higher proportion of stall feeding than villages in remote and inaccessible areas. Easy access to milk markets, provided farmers with an incentive to keep high producing animals. This is so because of the large differences in land resource and fodder availability and thus differences in development potential.

There is huge livestock population in the region but its production has not exploiting the full potential. Free grazing system of animals, called *Anna Pratha* or *Chhutta*, is a major socio-economic constraint in the livestock development programme. From April onwards, thousands of animals are used to graze in forests and grazinglands and they remain there up to September for grazing. Most of the animals remain underfed and result in low productivity.

The information on feed resources of Bundelkhand region, seasonal availability and nutritional value of the feed, feeding pattern of livestock and possible

reasons for low productivity etc. are need to be analyzed. This information may be helpful to recommend the feed required to supplement for optimum livestock production. The comparative study of both free range grazing and managed feeding system may help to address the problems related to overgrazing and free range feeding and will highlight the prospects and constraints related to both the systems. The feeding management based on appropriate nutritional technology may be adopted by the farmers to sustain the production potential even by low producing animals.

Keeping above points in view this study has been undertaken with the following objectives:

1. To identify feed resources available in the region in different seasons and their nutritional value.
2. To study the feeding practices of the livestock in the region and their comparison with standard feeding (NRC/ICAR feeding standards)
3. To make a comparative analysis of free range grazing and managed feeding system.
4. To identify the constraints and opportunities for conversion of free range grazing to managed feeding system.
5. To make recommendations for the development of new need based technologies where existing technologies do not meet the requirements of the different zones farmer type in the Bundelkhand.

CHAPTER II

REVIEW OF LITERATURE

Livestock is the integral part of rural economy in Bundelkhand region. The dependence of the people on livestock was reinforced due to poor agricultural productivity on account of large number of small and marginal holdings, poor resource base and low cropping intensity of about 113% (Government of UP, 1991). Average size of land holding is very less and therefore majority of the farmers falls in the category of small and marginal in Bundelkhand region (IGFRI, 1992). Agro-ecological variations influenced regional planing for feed and fodder availability. Feed resource productivity and allocation efficiency have much effect on milk production in Himachal Pradesh (Sharma and Singh, 1993). Tyagi (1997) presented the information on soil, vegetation, and Livestock of Bundelkhand region in an Altus. Lalitpur district of the region has a lot of opportunities for goat rearing due to very potential local breed of goat and availability of large forest area (Mishra and Dwivedi, 1997).

Ramana *et al.* (2000) studied the mineral content of soil, feed, fodder and blood plasma samples of dairy animals from southern transition zone of Karnataka and reported that more than 50% of the animal screened showed low copper and zinc in blood plasma. It is therefore, supplementation of these mineral is required in the ration of livestock for optimum production.

2.1 Feed resources

Hampaiah R, (1981) discussed the need for forage forestry is in view of the increased population, imbalance in the ecosystem and non availability of good quality fodder in semiarid regions. The concept, scope and management of forage forestry systems are discussed and constraints analyzed. Fodder trees, grasses and legumes suitable for cultivation in semiarid regions of India are listed.

Punj and Devendra (1988) reported that a major gap exists between the requirements and supplies of concentrates and green and dry fodder for feeding livestock in South Asia. To alleviate this shortage, it is essential to increase these feeds by growing more fodders, promoting agroforestry and social forestry, improving the nutritive value of crop residues and utilizing non-conventional feeds. Potentially valuable feeds include rubber (*Hevea brasiliensis*) seed cake, sal (*shorea robusta*) seed meal, spent anatto (*Bixa orellana*)seeds, tapioca waste, tea waste, babul (*Acacia nilotica*) seeds, slaughter house byproducts, animal organic wastes (cattle dung, poultry excreta), casia tora (*Cassia tora*) seeds, mango (*mangifera indica*)seed kernels, niger seed cake, karanj (*Pongamia pinnata*) cake, guar meal, p*rosopis juliflora* pods and cassava leaf meal.

Mudgal *et al.* (1988) reviewed feed resources in India. Present production provides only 56% concentrates and 64% green fodder for ruminant feeding, and discussed Research programmes on improving feed value and non conventional feeds are outlined and methods of implementing research findings.

Ravindran and Devendra (1988) reviewed the availability and utilization of animal feed resources in Sri Lanka. Sri Lanka is self-sufficient in roughage requirements, but deficient in concentrates. Rice straw is major feed resource available, but only a small proportion is utilized as feed. Other available crop residues and agro-industrial byproducts are under utilized and increasing their utilization represents the challenge for future. The need to develop appropriate feeding systems supported by "on-farm" evaluations has also been highlighted.

Tripathi AK (1991) reviewed the feed resources and nutrients available in the eastern region of India with respect to the requirements for the population of cattle and buffaloes. who indicated a huge deficit of concentrate (86.97%), greens (72.53%), digestible crude protein (74.83%) and total digestible nutrients (42.11%), however, there is a relative surplus of crop residues (19.7%). In this context, the strategies for optimizing crop residue utilisation for improving farmers return from milk are described. Means of improving straw utilization are urea treatment of straw, use of urea molasses, mineral licks and supplementation of straw with 5-10 kg of a legume fodder. For the concentrates, the importance of balanced cattle feed and bypass protein feed is discussed to achieve judicious use of available resources, maximum efficiency of nutrient utilization and increased income from milk.

Grasslands of the Bundelkhand Region, Uttar Pradesh, grasses constituted about 96% of the total forage, with legumes and forbs contributing only 2.5% and 1.8%, respectively (Singh *et al.*,1995). The major grasses were *bothriochloa pertusa*, *Apluda mutica*, *Desmostachya bipinnata*, *Dichanthium annulatum*, *Digitaria marginata*, *Eragrostis gangetica*, *Echinochloa colonum* and *setaria glauca*. Monthly forage yields ranged from 681 to 1522 g/m^2. Dry forage production ranged from 79 g/ m^2 in the summer to 965 g/m^2 in the rainy season, with a total annual production of 1241 g/ m^2. Forage production potential and nutritive evaluation (crude protein, fat, fibre, ash and carbohydrate) indicted that this grassland community is superior to many others in India.

Deoghare P R (1997) conducted a survey of availability of resources, and the income and employment potential of a sample of 451 goat raising households in Mathura District, Uttar Pradesh, India, in 1990-91. The main occupation of households was agriculture (68.51%) dairy (10.20%), goat keeping (20.40%), and sheep farming (0.89%). The number of family members and farm workers increased as land holding size increased. Average net income per household per year from livestock farming was 26.69% and from crop farming, 73.31%. Average labor employment per household per year from goat, sheep, buffalo and crop farming was 23.34%, 1.96%, 33.17% and 41.53%, respectively.

Gomez *et al* .(1998) estimated deficit of fodder requirement ranging from 6% in Tikamgarh district to 66% in rich rainfed zone comprising of Datia, Jalaun,

Hamirpur, Banda. Tyagi *et al.*(1997) estimated forage deficit of 38.95 in UP part and 27.99 in MP part in lakh tones. The area under fodder is about 1% only.

Saran *et al.* (2000) conducted a survey in UP part of Bundelkhand region during 1996-97. It revealed that crop residues constituted the major feed resources for the domesticated livestock population. The land and livestock holding patterns revealed that large farmers and farmers with big family size kept more livestock compared to small farmers. Berseem as green fodder, wheat and pea straws (dry fodder) constituted over 41%, 40% and 13% respectively of the total livestock feed availability from cultivated sources during *rabi*. Sorghum (green) contributed about 58 % of total *kharif* availability of livestock feed from cultivated sources followed by crop residues of Soybean (21.63%) and black gram (16.68%). More than 88% of annual availability of dry fodder and 86% green fodder was obtained during *rabi* season itself. *Anna Pratha*, a system of leaving the livestock tree for grazing was commonly practiced during lean seasons as also during rainy season. Soaked oil cakes and concentrates mixed with dry fodder (wheat and peas, straw) were also offered to the milch animals during the periods of green fodder scarcity.

2.2 Livestock feeding

Pandey *et al.* (1980) used multistage stratified sampling design in the selection of 120 farming households with at least one dairy cow or buffalo. Data on feed, milk output, lactation and season were analyzed to establish input-output relationships. Dairy input (i.e. fodder, concentrates, labor and other cash expenditure) and lactation were responsible for 40-85% of the variation in milk yield. Fodder was

the most significant production factor, followed by concentrates. Manipulation of feed levels had more effect on yield in the rainy season for cows but in the winter season for buffaloes. It is recommended that dairy farmers should be educated on the rational use of feed, labor etc.

ICAR (1985) published the feeding requirements of ruminants on the basis of their body weight. Feeding standard published by NRC (1988) and Pathak (1998) were also referred.

Desai et al. (1988) surveyed the feeding practices and types of feed given to dairy cattle and buffaloes in both tribal and non-tribal areas of Valsad, India, during summer, monsoon and winter of 1984-85. Samples of the 56 different types of feeds were analyzed and the chemical composition is given in tables. In tribal areas, forest tree leaves such as *asan, bivla, sisam* and *dhatirva* are given at about 3-5 kg in the summer, but in monsoon the animals maintained their body weight on pasture alone. In non-tribal areas, rice straw, rice polishing, guar seeds, guar meal, husk and concentrates were given. In coastal areas, unconventional feeds such as aal grass and tuavar leaves are given at 10-15 kg daily.

Rai *et al.* (1993) conducted a survey on goats at 2 villages . For farmers with small and marginal farms, and for landless farmers, flock size averaged 4.7, 4.2 and 3.5 respectively. On the 3 categories of farm, 75.0, 33.3 and 61.1% of goats were of the *Barbari* breed, the remainder being of the *desi* type. On the small and marginal farms, 25.0 and 16.5% respectively of goats were kept intensively.

Roggero *et al.* (1996) reviewed and defined the feeding system and the meaning that can be attached to the concept of sustainability and examined its application to existing systems. The attributes of sustainability are derived from an analysis of time-tested systems in Mediterranean and tropical regions. Farm organization, animal feed intake and product quality are considered to mean more than mere correspondence between feed requirements and crop production patterns. The rational management of rangeland and forestry systems was taken as an example of organization and planning of the use of renewable local resources. The multiple use of a specific feed resource and the development of a mixed pasture- cropping systems, with possible inclusion of fodder trees and shrubs, were considered as example of diversification and exploitation of local resources. The integration and fractionizing of diverse feed resources and the combination of different activities in a given area, are intended to constitute a global approach to land use aimed at reducing off-farm inputs whilst enhancing natural resources and nutrient recycling. This approach should facilitate the development of mixed and diversified systems, with alternative yield objectives, low environmental impact and reduced economic hazards. Examples are reported on the intercropping of forage, food and fuel sources in the tropics, and for cereal and livestock production in the Mediterranean basin. Flexibility of ruminant production and complementarities between animal species are also described as examples of integration and multiple uses of local feed resources. The possible roles of fodder species and the need to combine several activities into dynamic agricultural systems are discussed. Attention is also drawn to the vital links between farmers and

the wide rural community through coordinated actions that are appropriate to a mosaic of local conditions.

Ranjhan (1997) reported that goat farming is predominant in semi-arid regions of the country including Bundelkhand and plays an important role in contributing livestock outputs, enhancing rural livelihoods, providing stability to the farmers and its feeding habits suited to rain fed farming system. Badal and Dhaka (1998) analyzed feeding pattern of livestock in Bihar and concluded that green fodder intake was adjusted according to its seasonal availability.

Gomez *et al.*(1998) indicated that free range grazing and managed feeding were not mutually exclusive practices, but often coexisted, both at zonal, village and herd level. However, the relative importance of the two systems varied between zones, villages in each zone and households in each village.

Ranjhan (1999) reported that crop residues are the major feed resources and about 50 to 60 percent of DMI in large ruminants come through crop residues only. Pachauri *et al*, (1999) reported that goats potential is not often exploited fully due to lack of appropriate feeding systems.

Singh *et al.* (2001) reported that the agrarian economy of Jhansi district can be improve through forage based livestock production system. Grazing lands are main source of forage which is used for grazing. Owing to heavy grazing pressure and biophysical factors, grazing lands are in the different stages of degradation and the rate of deterioration is upwards and within a decade more than 6% moderately grazing

lands turned into ravines. The total forage deficit in the Jhansi district was estimated as 466588 DM ton/year which is about 45.96% of the estimated forage production.

Singh *et al.* (2001) assessed forest cover and impact of forest grazing by the application of remote sensing and GIS techniques and a plan of restoration of degraded forest of Jhansi district through appropriate grazing management suggested.

Yadav P.S. (2002) studied the feeding pattern of buffaloes in Panipat district of Haryana state and noticed that animals need dietary supplementation specially during lean period. Mahanta S.K. (2002) conducted an on farm experiment in Jhansi district and reported that concentrate supplement @ 1.0% of the body weight to grazing goats appears to be profitable under field conditions.

Sajjan Sihag *et al.* (2002) conducted survey for locally available feeds and feeding practices and socio-economic status of farmers in cotton growing area of Haryana. The farmers were classified according to land holding ie. Small farmers (2-5 acres), medium (5-10 acres) and large (>10 acres). The number of buffalo per family was higher in large farmers compared to others. Availability of *desi* cattle was higher in small farmer and lowest with large farmer. Number of milch buffalo and cattle, milk yield of cattle and buffalo and average milk yield per animal was significantly higher in the animals of large farmers than other categories.

Patange *et al* (2002) studied nutrient availability to milch Marathwadi buffaloes reared by different categories of farmers in Marathwada region of Maharastra State. Overall ration of milch buffaloes consisted of 5.41, 5.09 and 2.16 kg of green fodder, dry fodder and concentrate, respectively. Maximum green fodder (6.6

kg/h/d) was supplied during winter season, whereas, maximum dry fodder (6.01 kg) and concentrate (2.25 kg/h/d) were supplied during summer season. The nutrient supplied to the buffaloes varied significantly between the categories of farmers.

2.3 Chemical composition and nutritional status

Skarpe and Bergstrom (1986) reported that dry matter degradability is related to nutrient composition and varies widely among tree and shrubs species. A range of 38-78 percent DM degradability was observed in shrub and tree species.

Majumdar *et al*, (1988) reported high CP contents in all the browse species possessed throughout the year. In the monsoon or post monsoon season the CP content was on higher side and declined with maturity of the leaves.

Handa and Gill (1989) studies nutritional status of dairy animals kept by different categories of farmers in Punjab and observed that maximum amount of concentrate was fed during spring (March-May).

Albrecht and Broderick (1990) reported that digestibility was associated with higher NDF and ADF content. Ruminant livestock require fibre for normal rumen function but fibre also limits feed intake and degradability. Effect of lignin on digestibility of feeds were also described by various workers that lignin is the component most negatively correlated with degradability (Lapierre, 1993; Buxton and Fales, 1994; Dzowela *et al*, 1995).

Pradhan (1994) observed the deficit of the nutrients as DCP and TDN, when animals were fed on poor quality roughage based diet. Whereas Lal *et al* (1995)

observed nutritional status of lactating buffaloes in Hisar and emphasized the need to increase the nutrient supply to support the production potential of these buffaloes.

Singh *et al* (1998) reported nutritional status of buffaloes in rural area of Azamgarh district of Uttar Pradesh. Farmers maintaining low to medium yielding buffaloes require augmenting the nutrient supply by providing more of greens, concentrate and dry roughage to get the optimum production.

Singh AK *et al.* (1998) reported rumen degradability of the DM, organic matter (OM) and N of leaves of 5 fodder tree species, anjan (*Hardwickia binata*), bubul (*Acacia nilotica*), Kardhaie (*Anogeissus latifolia*), Mahaneem (*Melia azedarch*) and siris (*Albizia lebbeck*), was examined. In sacco studies were conducted using 45 nylon bags in 3 fistulated cattle maintained on mixed grass hay and green berseem . CP content differed between the species ranging from 10.34% (*A. nilotica*) to 16.52% (*A. lebbeck*). Higher ($P<0.05$) DM, OM and N disappearance was observed in *M. azedarach* leaves: *A. lebbeck* leaves had the lowest values. The results suggest that the tree leaves studied are a good source of nutrients for ruminants and suitable for use as supplements.

Singh *et al.* (1999) reported seasonal variation in DM and nutrient content of leaf samples from anjan (*Hardwickia binata*), babool (*Acacia nilotica*), Kardhaie (*Anogeissus latifolia*), mahaneem (*Melia azedarach*) and siris (*Albizia lebbeck*) was evaluated. Leaves obtained druing March- June were found to be suitable for feeding livestock. CP content in tree leaves was highest in the rainy season (16.94%) followed by summer (15.02%) and winter (13.63%).

Ramana *et al.* (2000) evaluated ten multipurpose tree and shrub species grown at NRC Agroforestry, Jhansi for their chemical composition and *insacco* degradation. The CP ranged from 7.6 to 29.2 percent on dry matter basis. Organic matter was as high as 95.13 and as low as 84.2 percent DM. A wide variation was observed in the insacco degradation values of different chemical constituents. Chemical composition and ISD of the MPTS leaf materials indicated that most species had potential to be used as protein source to supplement with grasses or crop residues in dry season.

Udeybie *et al.* (2000) analyzed the comparative dry matter intake and nutrient utilization efficiency in growing cattle and Buffaloes based on the results obtained from growth trials conducted in India. The DMI was higher in growing cattle than in growing buffaloes but buffalo calves utilized dry matter, energy and protein more efficiently for growth than cattle calves.

Negi *et al.* (2003) assessed eight browse species of Bundelkhand region for their proximate constituents. Crude protein varied from 8.9 – 25.2 percent in these shrubs in different seasons. There was less variation in cell wall constituents round the year. These shrub species may be used as source of forage during lean period.

2.4 Livestock production and economics

Tripathi *et al.* (1986) analyzed economics of production of cows' and buffaloes' milk during 1977-78 for 100 farms divided into 5 size groups ranging from<1 to >4 ha. Per cow and buffalo, resp.. Lactation averaged 210 and 70 days, maintenance cost Rs. 637.09 and Rs. 1004.03, milk yield 507 .65 and 620.15 l, milk production cost Rs. 1.17 and Rs.1.53/l, and farm business income Rs. 306.82 and Rs.

478.44. For both species, input/ output ratio averaged 1:1 .31 and net farm income averaged Rs. 323.35, tending to increase with farm size. Cobb-Douglas production functions showed that farmers of 2-3 ha used resources (roughages, concentrates and labor) most efficiently. Concentrates was the resource which had highest marginal value productivity, followed by roughage. This suggested that net income could be increased by higher expenditure on feeding.

Shalader *et al*, (1994) selected 120 milk producing households from six villages in mathura district of Uttar Pradesh during 1991-92. The sample comprised of 21 landless, 49 small (<2.0 ha), 28 medium (2.01 to 4.0 ha) and 22 large farmers (>4.0 ha); data on input/output and other factors were collected for cows and buffaloes. Production function analysis was carried out using multiple linear regression and marginal value products of various feed resources were calculated to examine resource use efficiency. Green fodder and concentrates contributed positively and significantly to the milk yield both for cows (linear milk yield functions:0.2096 and 0.6242) and buffaloes (0.0884 and 0.5755) on all farms except landless and medium, respectively. The stage of lactation had a negative and significant impact on the milk yield of buffaloes (-0.3616) . The elasticity of production (potential of milk production) of feeds and fodder were positive for all milk producing households. The marginal value products of concentrates were positive and significantly greater than unity for cows (2.8089) and buffaloes (2.8775) on all farms, whereas the marginal value products of green fodder (0.9432 and 0.4420 for cows and buffaloes, respectively) and dry odder

(0.3525 and 0.1110, respectively) were positive but less than unity indicating excessive use.

The factor-product relationship in the use of resources for milk production by *Murrah,* graded *Murrah* and local buffaloes was studied in Bulandshahar district of Uttar Pradesh during 1980-90 (Deepak Shah et al, 1995). The Cobb-Douglas production function revealed that concentrate was the most significant input influencing milk output. Green and dry fodder inputs also influenced milk production positively in almost all seasons. The stage of lactation had a negative effect on milk yield while the value of the animal was positively associated with milk production. The marginal product value of concentrate for milk production showed that in almost all cases it was used efficiently by *Murrah* buffaloes. However, the use of green fodder input was efficient only in the rainy season and only by local buffaloes. It is suggested that a reallocation of feed resources will increase milk production by buffaloes.

Lee Keejong *et al.* (1996) studied 40 dairy farms in the process of increasing their herd size in order to propose a model for establishing a competent family dairy farm in the Korea Republic. Although the average expansion target of 24 family farms was to increase herd size to 50 milking cows from the current 23, a herd size of 50 cows (comprising about 40 milking cows) was recommended, when factors such as the need to improve cow performance, higher dairy standards, and tightening environmental regulations in the future were considered. For a 50-cow enterprise on a family (1.5 labor units) farm, a new cattle barn, an automated concentrate feeding

system, a milking parlor, a labor saving manure handling system and mechanized forage production were fundamental prerequisites. It was estimated that an a additional investment of won 200 million was needed to achieve this. As it will take about seven years to increase herd size from 25 to 50 cows with on-farm breeding only, under reasonable reproduction and replacement rates, it is recommended that farmers begin to increase young stock two year before the completion of construction of a new barn. When the proposed herd size of 50 cows is attained, expected annual income is about won 60 to 70 million.

Jansen *et al.* (1997) used a capital budgeting model to determine the economic profitability of pasture improvement for livestock production using a mixture of *Brachiaria brizantha* and *Arachis pintoi* (BA) vs. *B. brizantha* with *Erythrina berteroana* (Silvopastoral system, SPS). A supplementary feeding system (SFS) for unimproved pastures is also evaluated as an alternative to increase meat production. Present values of incremental returns and internal rates of return on capital invested are calculated for all 3 systems. With the given meat prices, profitability of the BA and SPS greatly depends on the stocking rate and the length of the investment period considered. Financial benefits of the SPS are significantly lower than those of the BA system. However, the non-monetary benefits of incorporating trees in pastures are of difficult to evaluate and were not included in the financial analysis. Profitability of the SFS is lower than that of the BA system, but exceeded returns of the SPS, although it may prove unsustainable in the long run. Nevertheless, SPF constitutes an attractive

option for soils where the BA and /or SPS are difficult to established and for farmers without access to sufficient capital.

Paul *et al.* (2001) assessed the growth performance and economics of rearing *Nil-Ravi* buffalo male calves on different feeding regimes and concluded that rearing male calves on grazing with limited supplementation was more economical than stall feeding.

From the above review it is clear that there are regional variations in feed resources availability, feeding practices and problems related to free range grazing or *Anna pratha.* But on- farm evaluation is still required to quantify the nutrient requirement fulfilled and how much need to be supplemented for optimum livestock production in the region. The cost benefit analysis of both the feeding systems also need to be carried out. So that farmers can get better return from their limited resources.

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the methodological framework adopted in order to attain the specific objective of the study.

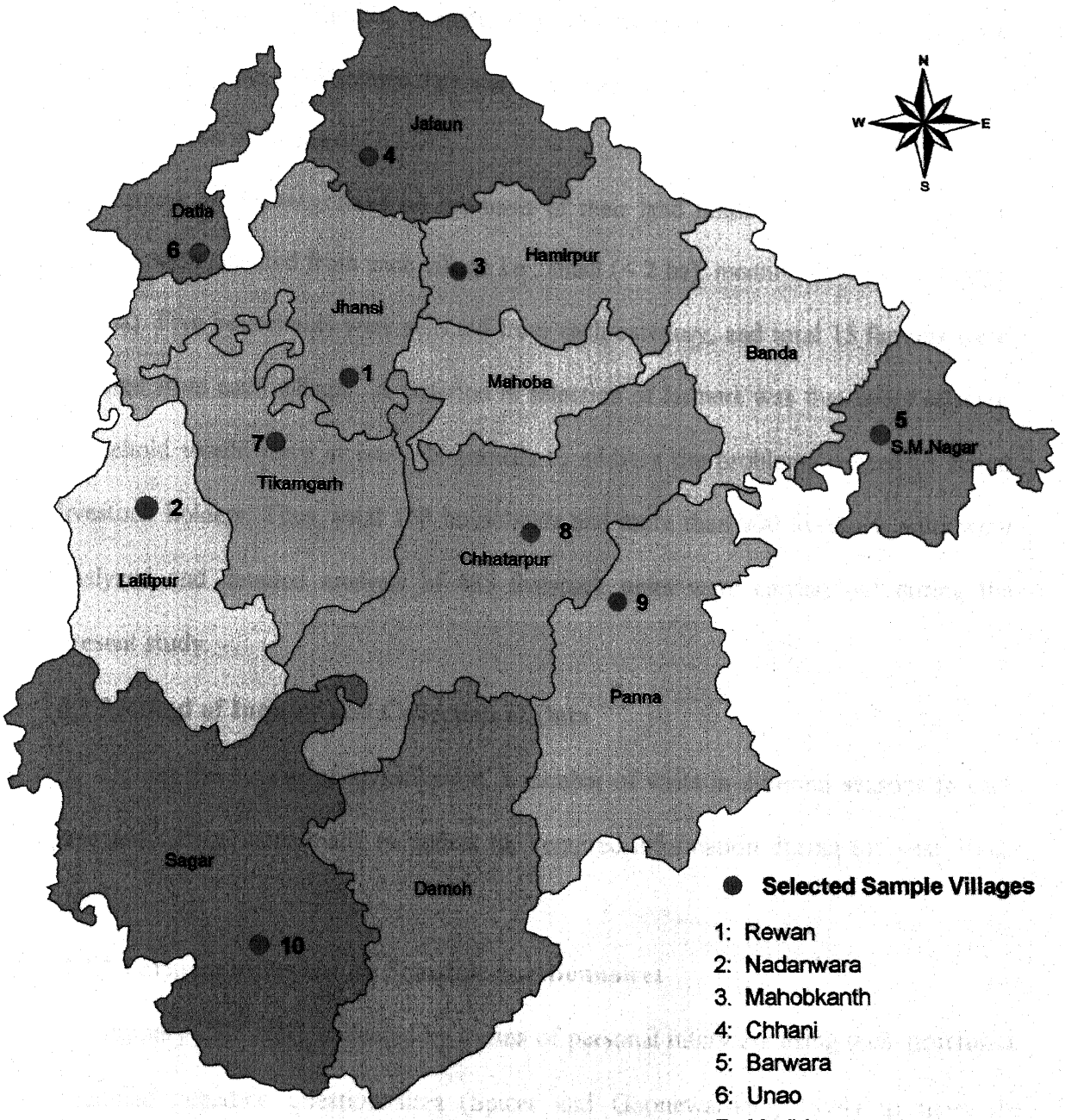
3.1 Sampling Procedure

3.1.1 Selection of villages

Before the selection of sample villages and farmers for study a rough zonation of the region was done. This zonation was based on the initial hypothesis regarding agro-ecological conditions that determine where free grazing system and managed feeding system are likely to occur. District statistical data published annually by the district authorities and topographical maps and Atlas of Bundelkhand (Tyagi , 1997) was considered for the zonation of the region . Different agro-ecological locations of the regions were also visited during ground truthing for the selection of the sample villages. So that selected village closely represent the all agro-ecological parts of the region.

Ten representative villages of Bundelkhand Region (Fig. 2) were selected. Namely Rewan (Jhansi), Nandanwara (Lalitpur), Mahobkanth (Hamirpur), Chhani

Fig.2: Location Map of Selected Villages in Bundelkhand Region



(Jalaun), Barwara (S.M.Nagar) administratively in Uttar Pradesh and Unnao (Datia), Madhia (Tikamgarh), Bamitha (Chhatarpur), Mandla (Panna), and Khemaria (Sagar) in Madhya Pradesh . The sample data were recorded from these selected villages.

3.1.2 Selection of farmers

Farmers were categorized on the basis of their land holding, three categories of farmers were selected from each village i.e.; small (< 2 ha), medium (2-4 ha) and large (>4 ha). Five households were selected from each category, and total 15 farmers were selected from each village. A criterion in selection of farmers was that every selected household would have at least six animals to address the problems related to actual livestock holders. Thus, total 150 households and more than 900 livestock units were analyzed and detailed analysis of 485 livestock units were carried out during the present study.

3.2 Method of Inquiry and Collection of Data

During the course of investigation, a number of visits in different seasons to each selected village were made to collect the required information during the year 2002-2003.

3.2.1 Farmers interview on Schedule questionnaires

Primary data were collected by means of personal interview using well structured, modified schedule questionnaires (Spicer and Goonewardene, 1994) to meet the objectives of the present study.

Information about socio-economic status of the farmer and the feeding practices followed by farmers for their livestock was collected during three seasons

viz. monsoon (July – October), winter (November-February) and summer (March - June). The quantity of feeds and fodder offered to animals during twenty four hours was recorded thrice in each season and 500 gm sample of each feed was collected for the analysis.

3.2.2 Village walk

Grazing practices, seasonal availability of manpower, traditional feeding practices etc. were discussed with village *pradhan / sarpanch*, village level government officials and other key person to collect the required information. The information of common problems related to livestock, crops and soil degradation and possible suggestions on the issues were also recorded.

3.2.3 Local markets

Prevailing rates of input and output commodities were recorded from local markets of the region in different seasons.

3.2.4 Secondary data

The secondary data on livestock population for fodder production, grazing resources, and forest resources of Bundelkhand region have been obtained from different issues of the statistical magazine of concern districts. Other relevant secondary data were also collected from district, block headquarters and other published materials.

3.3 Weighing of the Animals

Body weight of cattle and buffaloes were calculated on the basis of their body measurements using modified shalffers formula (Thomas and shastry, 1991) as follows:

$$\text{Live weight (in seers)} = \frac{(\text{Girth}) \times (\text{length})}{Y}$$

Where

Y= 9.0, if girth is less than 65 inches

= 8.5, if girth in between 65 –80 inches

= 8.0, if girth is over 80 inches

and one seer = 0.93 kg.

Sample units of goat and sheep were weighed by hanging them on spring balance. Body weight of lactating cattle, buffaloes and small ruminants were recorded once in a season. But change in body weight of growing cattle and buffaloes were recorded at monthly interval for one year.

3.4 Plan of On-farm Experiment

As per the availability of livestock and feeding system as adopted by the farmers, animals were grouped for detail feeding analysis. The efforts were made to keep similar type and equal number of livestock in each group of farmers and feeding systems to minimize the variation in the field study. Two feeding systems F_1 and F_2 and three categories of landholders T_1, T_2 and T_3 were the variables and thus total six number of treatment blocks (F_1T_1 , F_1T_2 , F_1T_3 , F_2T_1, F_2T_2 , F_2T_3) were taken for comparative study of Free Range Grazing (FRG) verses Managed Feeding

(MF) system in lactating animals. Each livestock unit within the treatment group was considered as one replication. Following number of livestock were investigated in different season for a period of one year.

Table i: Number of replications (livestock) under detailed study

Type of livestock	Categories of farmers			
	Small	Medium	Large	Total
A. Feeding system analysis				
a. Lactating Cattle				
1. cows in Free Range Grazing	14	14	14	42
2. Managed feeding system	14	14	14	42
Total	28	28	28	84
b. lactating Buffaloes				
FRG	16	16	16	48
MF	16	16	16	48
Total	32	32	32	96
B. Feeding pattern for round the year				
3. Cattle heifers	21	21	21	63
4. Buffaloe heifers	24	24	24	72
5. Sheep	37	37	NA	74
6. Goat	32	32	32	96
Grand Total	174	174	137	485

The managed feeding system was adopted by the farmers for lactating animals only. Most of the growing cattle and buffaloes were reared under free range grazing system therefore, annual feeding pattern were recorded in three treatment categories of

landholders for growing cattle, buffaloes, sheep and goat. Large farmers were not rearing sheep in selected villages. Four buffaloes, seven sheep and twelve goats were replaced with similar animals in concerned categories due to Sale/death of the animals during the study.

3.5 Feeding and Management

Animals under free range grazing (FRG) system were mainly low producing cows, buffaloes, growing livestock, dry animals, goat and sheep. Resource poor farmers also adopted FRG system for their well producing livestock. From the start of summer to late monsoon season animals of FRG system were send for the grazing at early morning about 6:00 am in all the selected villages. They graze in community lands or crop harvested agricultural lands without any restriction. However one follower is taken care in case of buffaloes, sheep and goat and other costly livestock. The grazing hours were recorded for all the animals under experiment. In evening animals return to their home and they were offered dry fodder mainly crop residues and some home made concentrate. Lactating animals were fed with concentrate during milking time only. In winter season FRG system did not existed, and all the livestock were managed with limited grazing as in managed feeding system.

The managed feeding (MF) system of livestock included stall feeding, cut and carry system for rangeland grasses, rotational grazing and feeding fair amount of concentrates. Farmers adopted managed feeding system for the lactating animals specially for milking buffaloes. In this system animals were allowed to graze for a limited hours (3 to 4)on personnel lands, but major amount of feeds received were cut

and carry grasses, crop residues and concentrate mixture. Wheat straw mixed with water soaked concentrate mixture called "*Sani*" was the common feeding practice in the region. Drinking water were offered by the farmers to their livestock usually once in a day and twice in summer season. The quantity of green fodder, dry fodder and concentrate consumed by the livestock in 24 hour and left refusal were recorded in schedule proforma thrice in each season.

3.6 Calculation of Adult Cattle Unit (ACU)

To convert livestock population in to Adult Cattle Unit (ACU), the following conversion formula (Tyagi, 1997) has been applied.

$$\text{One ACU} = \frac{\text{Weight of livestock x livestock nos.}}{350}$$

Where:

Weight of cow (over 3 years)	= 350 kg
Weight of cow (below 3 years)	= 200 kg
Weight of buffaloes (over 3 yeas)	= 400 kg
Weight o buffaloes (below 3 years)	= 250 kg
Goat/sheep equivalent to	0.2 cow unit each

3.7 Calculation of Feed Intake of Animals During Free Range Grazing

Feed intake of cattle and buffaloes during grazing was estimated by clipping random quadrates in grazing areas. The quadrate method was used earlier (Mahanta et al, 2002) for the estimation of biomass yield of rangelands utilized in grazing. The quadrates (1 m x 1m size) were randomly selected within the grazinglands at morning. The number of quadrates selected varied from 3 to 9 as per the size of grazing area.

The total fodder biomass of each quadrate was harvested and collected for weighing and then recorded the number of livestock grazing that area. The random quadrates were again selected and clipped on the next day morning within the same grazing land. Difference of the fodder biomass of that area was divided by the number of grazing livestock, and thus, estimated the fodder intake with the following assumptions:

1. All the livestock grazing the area have equal opportunity to graze and eating equal amount of fodder biomass.
2. Over night fodder growth in rangelands considered negligible.

Feed intake of goat and sheep during grazing hours could not be estimated due to their feeding habits of grazing, browsing and lopping. However, supplementary feed offered to these owines were recorded.

3.8.1 Preparation of samples for chemical analysis

The samples of individual feed collected from villages were oven dried at 70 °C till the constant weight. They were then grounds in Willy mill to pass 1 mm sieve and preserved in air tight polythene bags until subjected to proximate analysis, cell and cell wall composition and invitro digestibility.

3.8.2 Determination of Moisture

It was determined by drying a known weight of samples at 100 °C in the hot air oven till a constant weight was recorded.

3.8.3 Proximate analysis

All the determinates under proximate analysis were carried out in duplicate by method described by the Association of Official Agricultural

Chemist, (AOAC, 1990) Washington in their book entitled Official Method of Analysis.

3.8.4 Cell wall composition

Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were estimated by the methods suggested by Goering and Vansoet (1970). Hemicellulose was calculated as difference of NDF and ADF. Lignin was estimated in ADF residue by treating the residue with 72% (w/w) sulphuric acid for 3 hours at 20 to 30°C. The cellulose was calculated as the different between ADF and ligrin. All determinations were carried out in duplicate.

3.8.5 *Invitro* dry matter digestibility

Invitro dry matter digestibility of forage samples was done as suggested by Vansoet et al (1966).

3.8.6 Determination of DCP and TDN

Digestible Crude Protein (DCP) and Total Digestible Nutrients (TDN) values for different feeds were computed using the digestibility values of Sen and Ray (1971) and NRC (1988).

3.9 Economics of Milk Production

In order to evaluate among treatment groups the economics of individual treatment was worked out in both feeding systems as well as for the categories of farmers at prevailing rates of inputs and output in the market.

3.10 Statistical Analysis

The data pertaining to the present investigation were subjected to statistical analysis by the method described by Snedecor and Cochran (1967).

1. The randomized block design (factorial) for comparison of free range grazing Verses managed feeding system.
2. Standard measures of central tendency and dispersion were used for working out means of treatment groups.

3.11 Limitations of the Study

The study is perceived to have the following limitations:

1. Since, the farmers in the study area do not maintain proper record, in spite of all the possible care in collecting data, the errors in primary data can not be ruled out.
2. Since the study is based on one-year cross-sectional data, the results may vary for other years with the agro-climatic changes in the region.

CHAPTER IV

RESULTS

The information generated during this study have been categorized and presented in a manner to facilitate the critical scrutiny of the findings on the topic nutritional evaluation of feed resources and comparative analysis of free range grazing verses managed feeding system in Bundelkhand region.

4.1 Socio-Economic Status of Sample Farmers in the Region

Three categories of farmers were selected for this study i.e. small, medium and large on the basis of their land holdings <2 ha, 2 to 4 ha, and > 4 ha, respectively. Majority of the sample farmers (56%) were in middle age group (35-60 years), and 30 percent were young (below 35 years), but only 14 percent farmers were old (above 60 years). Maximum number of old farmers (22%) were observed in large land holding category and young farmers were maximum in medium land holding category.

Educational status of the sample farmers revealed that maximum farmers were in illiterate category (36%) and educated up to primary standard (46.67%). Only 12.7% farmers passed Metric and 4.67% were Graduate, mainly from

Table 1 Age, education and land holding of the sample households

Particulars	Farmers categories						
	Small		Medium		Large		Percent
	Number	Percent	Number	Percent	Number	Percent	Mean
Age							
below 35 years	14	28	16	32	15	30	30
35-60 years	32	64	28	56	24	48	56
Above 60 year	4	8	6	12	11	22	14
Total	50	100	50	100	50	100	100
Education							
Illiterate	33	66	18	36	3	6	36.00
Primary	17	34	29	58	24	48	46.67
High School	0	0	3	6	16	32	12.67
Graduate	0	0	0	0	7	14	4.67
Total	50	100	50	100	50	100	100.00
Av.Land/household							
Irrigated (ha)	0.14	12.41	1.30	42.23	2.76	42.07	32.24
Unirrigated (ha)	1.02	87.59	1.79	57.77	3.80	57.93	67.76
Total (ha)	1.16	100.00	3.09	100.00	6.56	100.00	100.00

large hand holding category. The literacy status of the farmers increased upward with increase in land holdings. The maximum numbers of illiterate farmers were from small and medium landholders.

Average land holding for small, medium and large farmers were 1.26, 2.86 and 6.19 ha/family, respectively. The irrigated land was more with large categories of the farmers, whereas small and medium farmers have limited irrigated lands.

4.2 livestock Resources in the Region

Livestock is the integral part of rural economy in the villages. Cattle, buffaloes, goat and sheep are major livestock reared in the region. The number of other livestock like horses, camel, pigs and poultry were in negligible number in the region.

4.2.1 Livestock reared by the sample household

Data of total livestock reared by the 150 sample households in the region revealed that buffaloes were maximum reared livestock 510 (32.06%) than the cattle 477 (29.98%), goats 407 (25.58%) and sheep 197 (12.88%). The livestock distribution in different categories of farmers showed that buffalo was mainly reared by large (4.94/family) and medium (3.84/family) categories of the farmers. Moreover, maximum numbers of cattle were reared by small (3.74/family) and medium farmers (3.64/family). Majority of goat and sheep farmers was found from small and medium land holdings where as large farmers were not rearing sheep in the selected sample villages.

Table 2 Types of livestock reared by the selected farmers in Bundelkhand region

Types of livestock	Farmer categories							
	Small		Medium		Large		Total	
	Number	ACU	Number	ACU	Number	ACU	Number	ACU
Cattle								
Male > 3 Year	28	28	54	54	19	19	101	101
Female >3year	76	76	63	63	49	49	188	188
Growing < 3 year	83	47	65	37	40	23	188	107
Sub total	**187**	**151**	**182**	**154**	**108**	**91**	**477**	**396**
Cattle/ family	3.74	-	3.64	-	2.16	-	3.18	-
Milch cows/ family	1.02	-	0.92	-	0.74	-	0.89	-
Buffaloes								
Male > 3 Year	1	1	7	8	17	19	25	28
Female >3year	42	48	102	117	134	153	278	318
Growing < 3 year	28	20	83	59	96	69	207	148
Sub total	**71**	**69**	**192**	**184**	**247**	**241**	**510**	**494**
Buffaloes/ family	1.42	-	3.84	-	4.94	-	3.4	-
Milch Buff. / family	0.68	-	1.56	-	2.12	-	1.45	-
Sheep	155	31	42	8	0	0	197	39
Goat	265	53	105	21	37	7	407	81
Total Livestock	**678**	**304**	**521**	**367**	**392**	**339**	**1591**	**1010**
Av.livestock/ family	13.56	6.08	10.42	7.34	7.84	6.78	10.61	6.73
Av.livest. / ha land	10.76	4.83	3.64	2.57	1.26	1.09	3.08	1.96
Fodder crop								
Area (ha/ family)	0.02	-	0.27	-	0.49	-	0.26	-

ACU = adult cattle unit, equivalent to 350 kg body weight

Adult Cattle Unit (ACU) was calculated to estimate the feed requirements of different categories of livestock. ACU also reflects the actual pressure on feed resources available with sample households. The maximum number of livestock ACU were reared by medium farmers (7.84 ACU/ household) as compared to large (6.78 ACU/ household) and small farmers (6.08 ACU /household). However, the pressure of ACU on feed resources was maximum in small land holding category and the number of ACU/ ha land for small, medium and large categories were 4.82, 2.57 and 1.09 respectively.

4.2.2 Livestock population of Bundelkhand region

The livestock population of Bundelkhand region in the years 1985 and 2001 was taken from the statistical reports published by district authorities. The study of overall livestock population dynamics in the region and the change in livestock population during 1985 to 2001 was searched out.

Total livestock population of Bundelkhand region in 1985 was 86.94 lakh in which cattle (59.14%) were highest, then goats (19.55%), buffaloes (17.14%) and lowest number of sheep (4.16%) . But in the year 2001, total livestock population of the region was 83.37 lakh, which showed the negative growth (- 4.10%) as compared to the livestock population in the year 1985. The major decrease was observed in cattle population (-9.36%), especially male cattle decreased by 4.59 percent during 1985 to 2001. However, the increase (3.15%) in buffalo's population in the region was noticed mainly owing to high increase in the population of female buffaloes. Goat and sheep increased by 1.58 and 0.53 percent, respectively from the

Table 3 Livestock population of Bundelkhand region

(Population in lakh)

Livestock	Cattle				Buffaloes				Goat	Sheep	Total
	Male >3 year	Female >3 year	Calves <3 year	Total	Male >3 year	Female >3 year	Calves <3 year	Total			
Year 1985											
Total livestock (lakh)	18.51	17.06	15.85	51.41	0.52	7.57	6.82	14.91	17.00	3.62	86.94
ACU (lakh)	18.51	17.06	9.06	44.62	0.59	8.65	4.87	14.11	3.40	0.72	62.85
Livestock %	21.29	19.62	18.24	59.14	0.59	8.70	7.85	17.14	19.55	4.16	100.00
Year 2001											
Total livestock (lakh)	14.52	13.49	15.27	43.28	0.50	9.08	8.06	17.64	18.37	4.08	83.37
ACU (lakh)	14.52	13.49	8.73	36.73	0.58	10.37	5.76	16.71	3.67	0.82	57.93
Livestock %	16.70	15.51	17.57	49.78	0.58	10.44	9.27	20.29	21.13	4.70	95.90
% Change (1985-2001)	-4.59	-4.10	-0.67	-9.36	-0.01	1.74	1.43	3.15	1.58	0.53	-4.10

Source: Statistical magazine of districts/commissioneries

year 1985 to 2001 in Bundelkhand region. The livestock population in terms of ACU was 62.85 lakh in the year 1985 and 57.93 lakh in year 2001.

4.3 Feed Resources

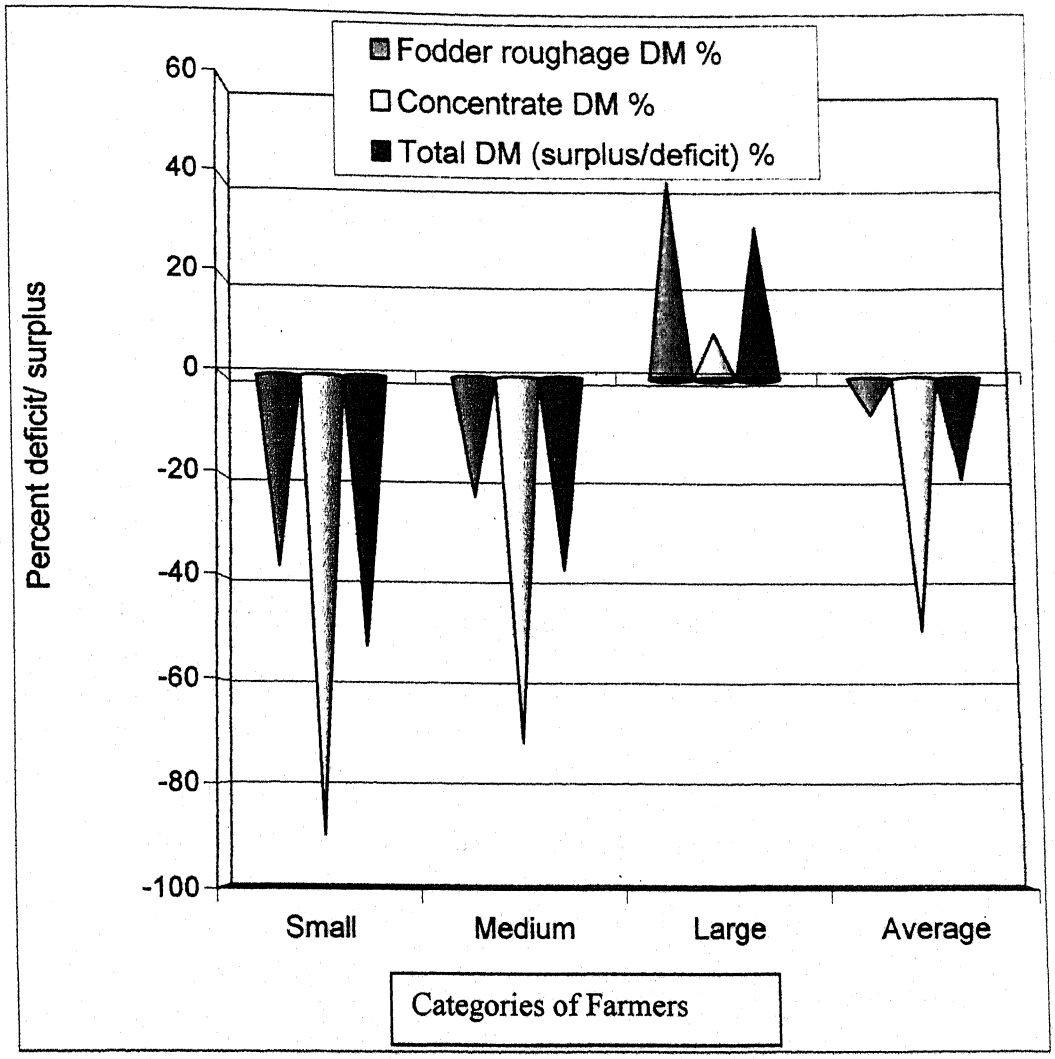
4.3.1 Requirement and availability of feed resources in the region

Feeds offered to the livestock in the region were categorized in roughage and concentrate. Dry fodder as crop residues, green fodder as monsoon grasses and cultivated fodder were the main roughage and cereal grain, oil cakes and pulse byproduts were fed as concentrate. Shrubs and tree leaves were fed to the sheep and goat especially during summer season. The major sources of feed availability were cropping lands, barren/waste land and grazing in forest/community land.

The roughage contributes about 77 percent and concentrates 23 percent in total fodder DM availability with the farmers in the village. Concentrate was available in less quantity with small and medium landholders. Crop residues were the major roughage and lowest amount of roughage received as cultivated fodder in the region (Fig 3 and Annexure 1).

Based on sample survey, feed resources availability, requirement and balance sheet for a year was calculated. The result shows that total fodder DM was deficit (20%) in the region in a year. The deficit of roughage was only 7.19 percent, but in case of concentrate it was 49.9 percent deficit on DM basis. Large farmers possessed surplus fodder roughage (+40%) and concentrate (+9.3%) whereas, small farmers

Fig. 3 Balance sheet of Feed Resources in the Bundelkhand region



The result is based on the survey of 150 households selected from different part of the region

were facing acute deficit of fodder roughage (-37.6%) and concentrate (-89.8%) in the region.

4.3.2 Nutritional evaluation of feed resources

The locally available feed resources as crop residues, cultivated fodder, concentrate and naturally grown grasses were evaluated by chemical and *invitro* methods. The feed samples were collected during on farm study from the selected villages of Bundelkhand region.

4.3.2.1 Crop residues

The crop residues, available with the farmers, were mainly straws of cereal and pulse crops. The organic matter (OM) content of crop residues was in the range of 86.12 to 93.09% on dry matter basis (Table 4). The highest amount of OM was observed in pigeon pea straw. The crude protein (CP) content in various crop residues varied from 3.42 to 14.86 percent. The cereal crop residues like wheat straw, paddy straw, barley straw and lentil straw contained the CP in the range of 3.42 to 4.37 percent. However, the CP content was found high in residues of leguminous crops, namely moongbean straw (12.62%), chickpea straw (10.22%) and soyabean straw (14.86%).

The values of cell wall fraction as Neutral Detergent Fibre (NDF) were varied from 66.40% (pigeon pea straw) to 78.24 percent (lentil straw). The Acid Detergent Fibre (ADF) contents in crop residues were in the range of 45.25 to 62.80 percent. The anti nutritional factor, Acid Detergent Lignin (ADL) content was highest (9.93%) in lentil straw and lowest (5.98%) in barley straw. *Invitro* dry matter digestibility

Table 4 Chemical composition of feed resources and their *invitro* digestibilities (%DM basis)

Feed resources	OM	CP	NDF	ADF	HC	Cellulose	ADL	Ash	IVDMD
Crpo residues									
Wheat Straw	89.63	3.42	75.20	53.62	21.58	47.21	6.41	10.37	44.61
Maize Stover	82.32	3.66	72.52	49.33	23.19	42.31	7.02	17.68	48.36
Barley Straw	86.70	3.70	76.81	50.10	26.71	44.12	5.98	13.30	46.11
Paddy Straw	86.12	3.71	68.45	51.28	17.17	44.41	6.87	13.88	42.32
Sorghum Stover	90.17	3.74	71.21	47.52	23.69	39.90	7.62	9.83	47.28
Mustard Straw	92.80	4.02	75.20	62.80	12.40	54.89	7.91	7.20	36.54
Lentil Staw	89.06	4.37	78.24	59.90	18.34	49.97	9.93	10.94	41.20
Chickpea Straw	86.20	10.22	74.22	51.85	22.37	43.75	8.10	13.80	58.71
Pea Straw	92.20	11.18	67.15	47.24	19.91	40.79	6.45	7.80	57.23
Pigeon pea Straw	93.09	12.40	66.40	45.25	21.15	38.92	6.33	6.91	61.92
Moong bean Straw	86.06	12.62	68.30	46.57	21.73	38.30	8.27	13.94	59.20
Soyabean Straw	88.11	14.86	69.31	48.11	21.20	40.01	8.10	11.89	57.89
Cultivated fodder									
Sorghum green	89.03	7.70	68.40	43.25	25.15	36.15	7.10	10.97	59.11
Maize green	87.30	8.40	65.31	40.07	25.24	33.16	6.91	12.70	58.87
Oat green	87.40	9.81	55.21	38.16	17.05	33.66	4.50	12.60	71.96
Berseem green	88.17	16.75	55.90	40.23	15.67	35.00	5.23	11.83	73.77
Berseem Hay	89.70	14.89	59.20	38.40	20.80	30.42	7.98	10.30	58.70

OM = organic matter, CP = crude protein, NDF = neutral detergent fibre, ADF = acid detergent fibre, HC = hemicellulose, ADL= acid detergent lignin
IVDMD = invitro dry matter digestibility

Table 5 Chemical composition of feed resources and their invitro digestibility (%DM basis)

Feed resources	OM	CP	NDF	ADF	HC	Cellulose	ADL	Ash	IVDMD%
Concentrates									
Wheat grain	96.02	12.29	15.40	9.10	6.30	9.01	0.09	3.98	84.38
Barley grain	93.28	13.47	26.85	16.47	10.38	16.32	0.15	6.72	78.56
Home made concentrate	90.32	21.41	29.56	18.06	11.50	17.48	0.58	9.68	79.05
Cotton seed cake	92.02	26.80	42.10	30.03	12.07	29.69	0.34	7.98	79.32
Linseed cake	92.02	31.97	47.60	20.42	27.18	19.61	0.81	7.98	80.22
Mustard cake	91.60	32.11	29.42	17.16	12.26	16.67	0.49	8.40	81.25
Ground nut cake	89.60	39.10	30.45	16.72	13.73	16.05	0.67	10.40	83.17
Grasses									
Mixed grass hay	89.76	3.20	69.34	40.12	29.22	32.71	7.41	10.24	48.20
Chrysopogon fulvus	89.50	3.92	71.80	42.40	29.40	35.38	7.02	10.50	50.23
Sehima nervosum	87.15	4.58	69.40	43.80	25.60	37.66	6.14	12.85	54.02
Dicanthium annulatum	90.08	4.70	72.10	36.70	35.40	30.51	6.19	9.92	60.45
Heteropogon contortus	90.61	5.02	71.55	42.55	29.00	35.75	6.80	9.39	51.16
Cenchrus ciliaris	88.90	5.86	68.12	44.06	24.06	38.14	5.92	11.10	58.61
Mixed mansoon grass	88.12	5.86	68.15	44.21	23.94	37.34	6.87	11.88	57.11
Cynodon dactylon	88.30	7.60	71.00	38.12	32.88	30.51	7.61	11.70	60.31

OM = organic matter, CP = crude protein, NDF = neutral detergent fibre, ADF = acid detergent fibre, HC = hemicellulose, ADL= acid detergent lignin
IVDMD = invitro dry matter digestibility
Home made concentrate = broken pulses, wheat floor and brans etc.

(IVDMD) ranged from 36.54 to 61.92 percent in different crop residues, minimum in lentil straw and maximum in pigeon pea straw (mainly leaves).

4.3.2.2 Cultivated fodder

The main cultivated fodder crops were berseem, sorghum, maize and oat in the region. The CP contents of these fodders were 16.75, 7.70, 8.40 and 9.81 percent, respectively. The OM content was in the range of 87.30 to 89.03% in cultivated fodder. The IVDMD of cultivated green fodder as berseem, sorghum, maize and oat were 73.77, 59.11, 58.87 and 71.96 percent, respectively.

4.3.2.3 Concentrates

The oil cakes and cereal grains were the main concentrates available with the farmers to feed their livestock. The OM content in various concentrates ranged between 89.60 to 96.02 percent, minimum in ground nut cake and maximum in wheat grains, respectively. The crude protein content was highest in groundnut cake (39.10%) and lowest in wheat grain (12.29%).

The cell wall fraction as NDF contents were in the range between 15.40 to 47.60%, where as ADF ranged from 9.10% to 30.03% in the different concentrates. It is revealed from table 5 that IVDMD of concentrates were ranged between 78.56 to 84.38 percent on DM basis.

4.3.2.4 Grass species

All the species of natural grown grasses contained the CP in the range of 3.92 to 7.60% on dry matter basis. However, mixed grass hay contained only 3.20% crude protein. Maximum crude protein was available in *Cynodon dectylon* (7.60%) and

minimum in *Chrysopogon fulvus* among the sample grass species. The mixed monsoon grass has the CP value of 5.86 percent (Table 5).

The highest value of NDF was observed in mixed monsoon grasses (44.21%) and lowest in *Dicanthium annulatum* (36.70%). The lignin content was in the range of 5.92 to 7.61 percent in *Cenchrus ciliaris* and *Heteropogon contortus*, respectively.

4.3.3 Nutritional evaluation of shrubs and tree leaves

Ten species of shrubs and tree leaves were analyzed for their chemical composition and *invitro* dry matter degradability. The samples of tree leaves were collected in monsoon, winter and summer seasons from the selected villages of Bundelkhand region. Season wise analysis and mean value of different constituents present in these leaves are given in Table 6 and 7.

The mean values of organic matter content in the leaves of shrubs and tree species varied from 87.02 to 92.24 percent of DM. It was found minimum in *Grewia flavescens* and maximum in *Madhuca indica*. The organic matter content was observed slightly higher in winter season, whereas ash content was observed higher in monsoon and summer season in all the species.

The CP content of shrubs and tree leaves were ranged from 9.65 percent in *Madhuca indica* to 18.75 percent in *Grewia flavescens*. CP content was found high in monsoon and summer season, whereas it was moderately lower in winter season in the shrubs and tree species.

The analysis of cell wall fraction revealed that mean NDF and ADF contents were in the range of 41.17 to 48.98 percent and 23.43 to 41.26 percent, respectively in

Table 6 Chemical composition of shrubs and tree leaves in different seasons (% DM basis)

Species	Seasons	OM	CP	NDF	ADF	HC	Cellulose	ADL	Ash	IVDMD
Madhuca indica (Mahua)	Monsoon	92.08	9.81	48.76	40.93	7.83	27.05	13.88	7.92	44.86
	Winter	93.37	9.16	49.87	41.60	8.27	26.64	14.96	6.63	42.09
	Summer	91.27	9.99	48.31	41.24	7.07	26.53	14.71	8.73	44.10
	Average	**92.24**	**9.65**	**48.98**	**41.26**	**7.72**	**26.74**	**14.52**	**7.76**	**43.68**
Ficus religiosa (Pipal)	Monsoon	87.63	11.87	47.20	40.86	6.34	30.99	9.87	12.37	52.71
	Winter	88.15	11.07	48.31	41.98	6.33	31.06	10.92	11.85	50.67
	Summer	86.02	12.51	45.66	40.02	5.64	29.85	10.17	13.98	51.20
	Average	**87.27**	**11.82**	**47.06**	**40.95**	**6.10**	**30.63**	**10.32**	**12.73**	**51.53**
Zizyphus jujuba (Ber)	Monsoon	88.23	12.86	44.76	33.52	11.24	27.90	5.62	11.77	41.68
	Winter	89.11	11.52	42.97	34.63	8.34	28.56	6.07	10.89	40.20
	Summer	89.82	11.07	42.12	32.11	10.01	26.23	5.88	10.18	41.92
	Average	**89.72**	**11.82**	**43.28**	**33.42**	**9.86**	**27.56**	**5.86**	**10.28**	**41.27**
Zizyphus nummularia (Jharberi)	Monsoon	87.24	14.25	45.62	33.90	11.72	29.13	4.77	12.76	54.60
	Winter	88.30	13.70	47.80	39.17	8.63	33.26	5.91	11.70	51.98
	Summer	88.48	13.32	44.11	32.06	12.05	27.19	4.87	11.52	55.03
	Average	**88.01**	**13.76**	**45.84**	**35.04**	**10.80**	**29.86**	**5.18**	**11.99**	**53.87**
Flacourtia indica (Kanker)	Monsoon	90.23	18.56	40.71	30.07	10.64	21.17	8.90	9.77	50.12
	Winter	91.70	11.12	48.28	34.10	14.18	23.33	10.77	8.30	48.20
	Summer	90.05	14.10	39.13	28.03	11.10	19.22	8.81	9.95	49.30
	Average	**90.66**	**14.59**	**42.71**	**30.73**	**11.97**	**21.24**	**9.49**	**9.34**	**49.21**

OM = organic matter, CP = crude protein, NDF = neutral detergent fibre, ADF = acid detergent fibre, HC = hemicellulose, ADL= acid detergent lignin
IVDMD = invitro dry matter digestibility

Table 7 Chemical composition of shrubs and tree leaves in different seasons (% DM basis)

Species	Seasons	OM	CP	NDF	ADF	HC	Cellulose	ADL	Ash	IVDMD
Acacia catechu	Monsoon	87.52	17.70	48.16	32.20	15.96	24.10	8.10	12.48	57.30
(Khair)	Winter	88.31	15.31	54.07	35.97	18.10	27.11	8.86	11.69	53.62
	Summer	88.06	13.22	42.10	28.80	13.30	21.08	7.72	11.94	56.91
	Average	**87.96**	**15.41**	**48.11**	**32.32**	**15.79**	**24.10**	**8.23**	**12.04**	**55.94**
Helicteres isora	Monsoon	88.37	16.51	47.48	32.42	15.06	26.66	5.76	11.63	62.40
(Maror Phali)	Winter	87.10	16.50	50.23	35.02	15.21	28.04	6.98	12.90	58.31
	Summer	88.56	15.63	44.50	30.27	14.23	24.67	5.60	11.44	62.11
	Average	**88.01**	**16.21**	**47.40**	**32.57**	**14.83**	**26.46**	**6.11**	**11.99**	**60.94**
Securinega virosa	Monsoon	89.55	19.67	39.47	22.15	17.32	17.79	4.36	10.45	73.51
(Chakedi)	Winter	90.12	15.08	45.93	27.00	18.93	21.20	5.80	9.88	70.02
	Summer	90.23	15.89	38.12	21.13	16.99	16.83	4.30	9.77	72.16
	Average	**89.97**	**16.88**	**41.17**	**23.43**	**17.75**	**18.61**	**4.82**	**10.03**	**71.90**
Ehretia aspera	Monsoon	88.41	20.11	43.62	32.18	11.44	24.26	7.92	11.59	56.22
(Tamoi)	Winter	89.07	16.62	47.83	34.06	13.77	24.20	9.86	10.93	54.17
	Summer	87.63	14.47	38.66	27.40	11.26	20.42	6.98	12.37	55.86
	Average	**88.37**	**17.07**	**43.37**	**31.21**	**12.16**	**22.96**	**8.25**	**11.63**	**55.42**
Grewia flavescens	Monsoon	87.03	21.78	45.30	32.55	12.75	24.54	8.01	12.97	59.81
(Jungle Jalebi)	Winter	87.68	16.61	49.14	36.12	13.02	26.21	9.91	12.32	57.06
	Summer	86.35	17.85	42.00	30.18	11.82	22.42	7.76	13.65	58.27
	Average	**87.02**	**18.75**	**45.48**	**32.95**	**12.53**	**24.39**	**8.56**	**12.98**	**58.38**

OM = organic matter, CP = crude protein, NDF = neutral detergent fibre, ADF = acid detergent fibre, HC = hemicellulose, ADL= acid detergent lignin
IVDMD = invitro dry matter digestibility

shrub species. The maximum ADF was recorded in *Acacia catechu* (54.07%) during winter and minimum in *Securinega virosa* (38.12%) in summer season. The ADF content was highest in *Ficus religiosa* (41.98%) in winter and lowest in *Securinega virosa* (21.13%) summer season. The hemicellulose content of these species was in the range of 6.10 to 17.75 percent.

The anti nutritional factor acid detergent lignin (ADL) was observed in the leaves of all the species. The mean ADL content was ranged from 4.82 to 14.52 percent in these species. Maximum lignin content was observed in *Madhuca indica* (14.96%) in winter season and minimum in *Securinega virosa* (4.30%) during summer season. The lignin content was observed higher during winter season and comparatively lowers in monsoon season in the most of the species.

The *invitro* dry matter digestibilities of shrubs and tree leaves were varied from 43.68 to 71.90 percent. The IVDMD value was highest in *Securinega virosa* (73.51%) in monsoon season and lowest in *Madhuca indica* (42.09%) in winter season. The season wise study shows that IVDMD values were higher in monsoon than summer season and lowest in winter season.

4.4 Comparative Analysis of Free Range Grazing and Managed Feeding System

Major parameters for comparison of both the feeding systems were feed intake, nutrient requirement and supply, production of livestock and economic profitability.

4.4.1 Feed intake of milch cows

Information on quantity of feed and fodder offered to the livestock were obtained through a fair degree of precision with the cooperation of farmers during the field survey and on form trial. Normally three types of feeds viz., green fodder, dry fodder (crop residues) and concentrates were being fed to the milking cows and buffaloes. The green fodder consisted of locally available green grasses and edible weeds from cropped land during monsoon and winter season. Cultivated fodders were sorghum in monsoon while berseem and oat in winter season grown by the large and medium categories of farmers. The feed intake of cattle includes fodder from grazing and supplemented as stall feeding (Table 8 and Annexure 2).

The dry matter intake of milch cows in monsoon season for managed feeding (MF) system was significantly higher (P >0.05) than free range grazing (FRG) system (7.18 kg and 5.90kg/h/d, respectively). There was no much variation in DMI of cows in different categories of farmers during monsoon season. Green fodder intake (6.25 to 7.10 kg/h/d) in monsoon season was almost similar in both the feeding systems as well as among the animals reared by small medium and large categories of farmers. The dry fodder, mainly crop residues intake in the cows of managed feeding system (4.79 kg) was significantly higher as compared to FRG system (3.41kg/h/d). Intake of concentrates (mainly feed grains and oil seed cakes etc) in both the feeding systems (1.12 and 1.22 kg/h/d) were not differed significantly in monsoon season, however large farmers in MF system given significantly higher amount of concentrate compared to other categories of farmers.

In the winter season, when free range grazing does not exist, DMI of milch cow was found not significantly different among the FRG and MF system (6.98 and 7.07 kg/h/d, respectively). However, DMI of milch cows with large farmers were significantly higher (P >0.5) as compared to small and medium categories of farmers in both the feeding systems. Green fodder intake of milch cows in winter season was almost similar in the FRG and MF system (5.37 and 5.43kg/h/d) but significant variation was found in different categories of farmers. Cows with large farmers received significantly higher green fodder compared to small and medium landholders.

In summer season green fodder was not available to the animal in free range grazing system and cows of small farmers in managed feeding system. However, medium and large categories of farmers in MF system fed their milch cows with some amount of green fodder 1.06 and 1.52 kg/h/d, respectively. The intake of crop residues in MF system by the milch cows (4.83 kg) was significantly higher compared to FRG system (3.96 kg) in summer season. But dry fodder intake of animals was almost similar among all categories of farmers in FRG system. The variation in concentrate feeding to the milch cows was significant among feeding systems and categories of farmers. The milch cows in MF system were fed with higher amount of concentrate (1.81 kg) as compared to cows in FRG system (0.71 kg/h/d/) fed at the time of milking only.

Total feed intake (on fresh basis) by the milch cows in MF system was significantly higher (7.50 kg) as compared to animals in FRG system (4.69 kg/h/d) in summer season, but not significantly different among categories of the farmers. The

Table 8 Season wise DMI of milch cows in different feeding systems

Season	Particulars	Free range grazing				Managed feeding system				SEM	CD at 5%	
		Small	Medium	Large	Mean	Small	Medium	Large	Mean	±	FC	FS
Monsoon (July-Oct)	Green fodder	6.77	6.70	6.75	6.74	7.10	6.31	6.25	6.55	0.31	NS	NS
	Dry fodder	3.45	3.38	3.41	3.41^{x}	4.78	4.80	4.80	4.79^{y}	0.44	NS	1.06
	Concentrate	1.05	1.07	1.25	1.12	1.10	1.15	1.41^{b}	1.22	0.10	0.28	NS
	Total (fresh basis)	11.27	11.15	11.41	11.28	12.98	12.26	12.46	12.57	0.67	NS	NS
	DMI(kg/h/d)	5.88	5.81	6.02	5.90^{x}	7.21	7.06	7.28	7.18^{y}	0.35	NS	0.84
Winter (Nov-Mar)	Green fodder	4.88^{a}	5.26^{ab}	5.98^{b}	5.37	4.95^{a}	5.30^{ab}	6.05^{b}	5.43	0.29	0.82	NS
	Dry fodder	4.96	4.80	4.75	4.84	4.94	4.87	4.80	4.87	0.22	NS	NS
	Concentrate	1.18	1.21	1.70^{b}	1.36	1.24	1.27	1.75^{b}	1.42	0.11	0.31	NS
	Total (fresh basis)	11.02	11.27	12.43	11.57	11.13	11.44	12.60	11.72	0.59	NS	NS
	DMI(kg/h/d)	6.79	6.78	7.36^{b}	6.98	6.85	6.90	7.47^{b}	7.07	0.18	0.51	NS
Summer (Apr-June)	Green fodder	0.00	0.00	0.00	0.00^{x}	0.00	1.06^{b}	1.52^{c}	0.86^{y}	0.09	0.25	0.22
	Dry fodder	3.86	3.98	4.05	3.96^{x}	4.67	4.70	5.12	4.83^{y}	0.26	NS	0.62
	Concentrate	0.54	0.70	0.95	0.73^{x}	1.56^{b}	1.70^{b}	2.17^{c}	1.81^{y}	0.15	0.42	0.37
	Total (fresh basis)	4.40	4.68	5.00	4.69^{x}	6.23^{b}	7.46^{bc}	8.81^{c}	7.50^{y}	0.50	1.41	1.20
	DMI(kg/h/d)	3.96	4.21	4.50	4.22^{x}	5.61^{b}	5.99^{bc}	6.90^{c}	6.17^{y}	0.38	1.07	0.91
Average	Green fodder	3.88	3.99	4.24	4.04	4.02	4.22	4.61^{b}	4.28	0.24	0.68	NS
	Dry fodder	4.09	4.05	4.07	4.07^{x}	4.80^{ab}	4.79^{ab}	4.91^{b}	4.83^{y}	0.30	0.85	0.72
	Concentrate	0.92	0.99	1.30^{ab}	1.07^{x}	1.30^{ab}	1.37^{ab}	1.78^{b}	1.48^{y}	0.13	0.38	0.32
	Total (fresh basis)	8.90	9.03	9.61	9.18^{x}	10.11	10.39	11.29^{b}	10.60^{y}	0.59	1.63	1.39
	DMI(kg/h/d)	5.54	5.60	5.96	5.70^{x}	6.56^{ab}	6.65^{ab}	7.21^{b}	6.81^{y}	0.40	1.14	0.97

Figures superscript with different alphabet a, b, c, d....differed significantly in a row.
Figures superscript with x, y showing significant difference of mean values.

CD: FC= Critical Difference due to Farmers Categories
FS= Critical Difference due to Feeding Systems

similar trend was observed for the DM intake also. The DMI (kg/h/d) for small , medium and large categories was recorded as 3.96 , 4.21 and 4.50kh/h/d in FRG system and 5.61, 5.99 and 6.90kg/h/d in MF system, respectively in summer season.

Year round average feed intake of milch cows revealed that intake of dry fodder, concentrate, DMI and intake on fresh basis was significantly higher in the animals under MF system as compared to FRG system. The feed intake was found similar among the different categories of farmers in FRG system, whereas in MF system the large farmers fed their animals with significantly higher amount of dry fodder and concentrate compared to small and medium landholders.

4.4.2 DCP and TDN supplied to milch cows in different feeding system

Milch cows under managed system were fed round the year with higher ($P>0.05$) DCP and TDN (0.354 and 4.116 kg/h/d) as compared to cows under FRG system (0.315 and 3.959 kg/h/d). The supply of DCP and TDN level was moderately lower than ICAR recommended level in MF system. However, cows under FRG system were found deficit of 20.68 percent DCP and 14.67 percent TDN. Acute deficit of DCP and TDN were observed in summer season in FRG system, especially in cows with small and medium categories of farmers. Maximum supply of nutrient was noticed in winter season in both the feeding systems, when animals were not allowed for free range grazing (Table 9).

The study revealed that large farmers supplied significantly higher amount of nutrients to milch cows as compared to medium and small farmers. The supply of DCP and TDN was varied with the season in FRG system but milch cows under

Table 9 Daily DCP and TDN supplied to milch cows in different feeding systems

Seasons	Nutrients	Free range grazing				Managed feeding system				SEM ±	CD 5%	
		Small	Medium	Large	Mean	Small	Medium	Large	Mean		FC	FS
	Requirements											
	Av.B.W.of cows (kg)	318	327	341	329	328	342	359	343			
	DCP required (kg/h/d)	0.351	0.356	0.365	0.357	0.357	0.365	0.374	0.365			
	TDN required (kg/h/d)	3.880	3.970	4.110	3.987	3.980	4.120	4.260	4.120			
	Supply/Deficit											
Monsoon	DCP supplied (kg/h/d)	0.305	0.306	0.331	0.314^{x}	0.344^{a}	0.341^{a}	0.376^{b}	0.354^{y}	0.011	0.031	0.026
	%Deficit/surplus (±)	-13.02	-14.15	-9.21	-12.10	-3.53	-6.54	0.45	-3.17			
	TDN supplied (kg/h/d)	3.453	3.422	3.572	3.482^{x}	4.213	4.148	4.324	4.228^{y}	0.062	0.172	0.149
	%Deficit/surplus (±)	-11.01	-13.82	-13.10	-12.66	5.85	0.68	1.50	2.63			
Winter	DCP supplied (kg/h/d)	0.317^{a}	0.323^{a}	0.394^{b}	0.345	0.326^{a}	0.332^{a}	0.402^{b}	0.353	0.010	0.028	NS
	%Deficit/surplus (±)	-9.57	-9.34	7.83	-3.57	-8.80	-8.93	7.47	-3.29			
	TDN supplied (kg/h/d)	4.037^{a}	4.041^{a}	4.474^{b}	4.184	4.081^{a}	4.123^{a}	4.545^{b}	4.250	0.032	0.090	NS
	%Deficit/surplus (±)	4.05	1.78	8.86	4.95	2.53	0.08	6.69	3.15			
Summer	DCP supplied (kg/h/d)	0.166^{a}	0.188^{ab}	0.220^{b}	0.192^{x}	0.310^{c}	0.340^{c}	0.413^{d}	0.354^{y}	0.019	0.054	0.046
	%Deficit/surplus (±)	-52.67	-47.06	-39.64	-46.37	-13.22	-6.85	10.40	-3.04			
	TDN supplied (kg/h/d)	2.352^{a}	2.527^{a}	2.740^{b}	2.540^{x}	3.489^{c}	3.752^{c}	4.365^{d}	3.869^{y}	0.108	0.305	0.259
	%Deficit/surplus (±)	-39.38	-36.35	-33.33	-36.30	-12.33	-8.92	2.46	-6.10			
Average	DCP supplied (kg/h/d)	0.263^{a}	0.272^{a}	0.315^{b}	0.283^{x}	0.327^{b}	0.338^{b}	0.397^{c}	0.354^{y}	0.016	0.045	0.038
	%Deficit/surplus (±)	-25.09	-23.52	-13.67	-20.68	-8.52	-7.44	6.11	-3.17			
	TDN supplied (kg/h/d)	3.281^{a}	3.330^{a}	3.595^{b}	3.402^{x}	3.928^{c}	4.008^{c}	4.411^{d}	4.116^{y}	0.068	0.192	0.163
	%Deficit/surplus (±)	-15.44	-16.13	-12.52	-14.66	-1.317	-2.722	3.55	-0.11			

Figures superscript with different alphabet a, b, c, d.... differed significantly in a row.
Figures superscript with x, y showing significant difference of mean values.

CD: FC= Critical Difference due to Farmers Categories
FS= Critical Difference due to Feeding Systems

managed feeding received comparatively constant supply of DCP as well as TDN. There was a marginal deficiency of DCP (3%) round the year in managed feeding system. However TDN was deficit for the cows of MF system only in summer season.

4.4.3 Feed Intake of milch buffaloes

The dry matter intake of milch buffaloes was significantly higher in MF system (8.80 kg/h/d) as compared to FRG system (7.73kg/h/d) in monsoon season, but intake of DM to the buffaloes was similar among the farmers categories. In winter season DMI of buffaloes (9.01 and 9.06kg/h/d) not differed significantly in both the feeding systems. But large and medium categories of farmers offered significantly higher quantity of green fodder in MF system during winter season. The maximum green fodder was available in monsoon (8.05 kg/h/d) as well in winter (7.4 kg/h/d) to the buffaloes under both the feeding systems (Table 10).

The maximum dry fodder (6.24 kg/h/d) was offered to the buffaloes in MF system during summer season and lowest (4.43 kg/h/d) during monsoon by the farmers adopted FRG system. The dry fodder consisted of mainly crop residues like wheat straw, sorghum *kadbi* and straws of leguminous crop as moong, urd, gram, soyabean, pea etc. It was observed that in summer season dry fodder is the major source of dry matter (66.91%) in total ration of buffaloes. The DMI of milch buffaloes was observed significantly higher in MF system (8.39 kg/h/d) compared to FRG system (6.52 kg/h/d) during summer season.

Large farmers of MF system fed their milch buffaloes higher amount of DM (9.11 kg) as compared to medium (8.43 kg) and small landholders (7.61 kg/h/d) in

Table10 DMI of milch buffaloes in different feeding systems

Season	Particular	Free range grazing				Managed feeding system				SEM	CD at	5%
		Small	Medium	Large	Mean	Small	Medium	Large	Mean	±	FC	FS
Monsoon (July-Oct)	Green fodder	8.29	8.06	7.81	8.05	8.21	8.02	7.90	8.04	0.27	NS	NS
	Dry fodder	4.20	4.35	4.75	4.43^{x}	5.35	5.50	5.51	5.45^{y}	0.21	NS	0.50
	Concentrate	1.46^{a}	1.84^{b}	1.93^{b}	1.74^{x}	1.50^{a}	2.10^{bc}	2.15^{c}	1.92^{y}	0.07	0.19	0.17
	Total (fresh basis)	13.95	14.25	14.49	14.23^{x}	15.06	15.62^{b}	15.56^{b}	15.41^{y}	0.43	1.21	1.03
	DMI(kg/h/d)	7.33	7.75	8.12	7.73^{x}	8.38^{ab}	9.01^{b}	9.03^{b}	8.80^{y}	0.36	1.02	0.86
Winter (Nov-Mar)	Green fodder	6.15^{a}	7.80^{b}	8.25^{b}	7.40	6.20^{a}	7.84^{b}	8.30^{b}	7.45	0.45	1.27	NS
	Dry fodder	6.20	6.09	6.02	6.10	6.25	6.15	6.00	6.13	0.19	NS	NS
	Concentrate	1.50^{a}	2.11^{b}	2.20^{b}	1.94	1.50^{a}	2.10^{b}	2.24^{b}	1.95	0.10	0.28	NS
	Total (fresh basis)	13.85^{a}	16.00^{ab}	16.47^{b}	15.44	13.95^{a}	16.09^{ab}	16.54^{b}	15.53	0.47	1.33	NS
	DMI(kg/h/d)	8.41^{a}	9.25^{b}	9.38^{b}	9.01	8.46^{a}	9.31^{b}	9.41^{b}	9.06	0.29	0.82	NS
Summer (Apr-June)	Green fodder	0.00	0.00	0.91	0.30^{x}	0.00	1.83^{b}	2.72^{b}	1.52^{y}	0.48	1.35	1.15
	Dry fodder	5.10	5.49	5.63	5.41^{x}	6.35	6.20	6.18	6.24^{y}	0.26	NS	0.62
	Concentrate	1.52	1.81	1.94	1.76^{x}	2.11^{ab}	2.70^{b}	3.25^{c}	2.69^{y}	0.19	0.54	0.46
	Total (fresh basis)	6.62	7.30	8.48	7.47^{x}	8.46	10.73^{b}	12.15^{b}	10.45^{y}	0.66	1.87	1.58
	DMI(kg/h/d)	5.96	6.57	7.02	6.52^{x}	7.61^{b}	8.43^{bc}	9.11^{c}	8.39^{y}	0.49	1.38	1.17
Average	Green fodder	4.81	5.29	5.66	5.25	4.80	5.90^{b}	6.31^{b}	5.67	0.39	1.09	NS
	Dry fodder	5.17	5.31	5.47	5.31^{x}	5.98^{b}	5.95^{b}	5.90^{b}	5.94^{y}	0.23	0.65	0.57
	Concentrate	1.49^{a}	1.92^{b}	2.02^{b}	1.81^{x}	1.70^{ab}	2.30^{bc}	2.55^{c}	2.18^{y}	0.12	1.34	0.29
	Total (fresh basis)	11.47	12.52	13.15^{b}	12.38^{x}	12.49	14.15^{bc}	14.75^{c}	13.80^{y}	0.53	1.49	1.27
	DMI(kg/h/d)	7.23	7.86	8.17^{ab}	7.75^{x}	8.15^{ab}	8.91^{b}	9.18^{b}	8.75^{y}	0.40	1.13	0.96

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summer season. However DM intake was significantly lower during summer in buffaloes under FRG system in all the categories of farmers.

The concentrate feeding to milch buffaloes was higher in summer season. Buffaloes under managed feeding system received significantly higher amount of concentrate as compared to FRG system in all categories throughout the year. The large and medium farmers fed significantly higher amount (2.55 and 2.30 kg/h/d) of concentrates as compared to small landholders (1.70 kg/h/d) in MF system. Feeding of water soaked oil cakes mixed with wheat straw called " *Sani*" is common practice in the region. Groundnut cake, mustard cake, cotton seed cake, gram *chuni*, wheat and barley grain, were the major constituents of concentrate. Homemade concentrate mixture also supplied to the buffaloes, which includes pulse *chuni*, grin of millets and *brans* as available to the farmers.

Year wise average DMI of milch buffaloes was significantly higher (8.75 kg/h/d) in MF system as compared to FRG system (7.75 kg/h/d). The DMI was not differed significantly among the categories of farmers in FRG system. However, in managed feeding system large and medium farmers fed their buffaloes significantly higher DM (9.18 and 8.91 kg/h/d) as compared to small land holders (8.15 kg/h/d).

Buffaloes were fed comparatively better than milch cows by all the categories of farmers in the region. Medium as well large farmers have taken care of buffaloes feeding, in all the season while milch cows were fed better by large farmers only in both the feeding systems.

4.4.4 Daily DCP and TDN supply to milch buffaloes in different feeding systems

The plane of nutrition of milch buffaloes was assessed in terms of digestible crude protein (DCP) and total digestible nutrients (TDN). Daily supply of DCP and TDN were compared with standard feeding recommendations (ICAR, 1985). Medium and large farmers those adopted MF system fed their milch buffaloes almost the recommended level of nutrients in all the seasons, but buffaloes of small farmers could receive the deficit amount of DCP and TDN (-18.62 and –9.72 percent, respectively).

Deficit supply of nutrients was observed for the buffaloes in FRG system in all categories of farmers through out the free range grazing period (monsoon and summer season). Maximum deficit of DCP and TDN was observed in summer season for the buffaloes under FRG system. In monsoon and summer season DCP and TDN supply to milch buffaloes were significantly ($P > 0.05$) higher in managed feeding system compared to FRG system(Table 11).

In winter season, when free range grazing does not exist, buffaloes under FRG system were also fed by the farmers as managed feeding system, and no significant difference were observed in both the feeding systems in winter season. However farmers category wise, nutrient supply was increased as per size of land holdings.

Year wise average nutrient supply revealed that buffaloes under managed feeding system received recommended level of nutrients, even surplus amount of DCP (+5.90%) and TDN (+2.74%) in case of large farmers. But buffaloes under FRG system received significantly lower amount of nutrient compared to MF system. The amount of nutrients was also deficit than recommended level with an average

Table 11 Daily DCP and TDN supplied to milch buffaloes in different feeding systems

Seasons	Nutrients	Free range grazing				Managed feeding system				SEM ±	CD 5%	
		Small	Medium	Large	Mean	Small	Medium	Large	Mean		FC	FS
	Requirements											
	Av.B.W.of buffalo (kg)	392	398	405	398	406	409	415	410			
	DCP required (kg/h/d)	0.519	0.522	0.526	0.522	0.526	0.528	0.531	0.528			
	TDN required (kg/h/d)	5.370	5.430	5.500	5.433	5.510	5.540	5.600	5.550			
	Supply/Deficit											
Monsoon	DCP supplied (kg/h/d)	0.409^{a}	0.464^{b}	0.482^{b}	0.451^{x}	0.438^{b}	0.525^{c}	0.530^{c}	0.497^{y}	0.011	0.031	0.027
	%Deficit/surplus (+)	-21.25	-11.21	-8.45	-13.61	-16.82	-0.65	-0.12	-5.84			
	TDN supplied (kg/h/d)	4.339^{a}	4.653^{b}	4.886^{b}	4.626^{x}	4.943^{bc}	5.419^{c}	5.443^{c}	5.268^{y}	0.096	0.273	0.232
	%Deficit/surplus (+)	-19.20	-14.30	-11.16	-14.85	-10.29	-2.19	-2.81	-5.08			
Winter	DCP supplied (kg/h/d)	0.425^{a}	0.531^{b}	0.548^{b}	0.501	0.426^{a}	0.532^{b}	0.554^{b}	0.504	0.012	0.034	NS
	%Deficit/surplus (+)	-18.19	1.76	4.26	-4.01	-18.95	0.66	4.40	-4.59			
	TDN supplied (kg/h/d)	5.211^{a}	5.852^{b}	5.952^{b}	5.672	5.245^{a}	5.882^{b}	5.978^{b}	5.702	0.057	0.162	NS
	%Deficit/surplus (+)	-2.96	7.77	8.22	4.39	-4.82	6.17	6.76	2.73			
Summer	DCP supplied (kg/h/d)	0.314^{a}	0.361^{ab}	0.392^{b}	0.356^{x}	0.420^{b}	0.518^{c}	0.602^{d}	0.513^{y}	0.017	0.048	0.041
	%Deficit/surplus (+)	-39.53	-30.76	-25.43	-31.87	-20.09	-1.91	13.42	-2.81			
	TDN supplied (kg/h/d)	3.680^{a}	4.085^{b}	4.376^{b}	4.047^{x}	4.737^{c}	5.335^{d}	5.840^{e}	5.304^{y}	0.102	0.290	0.246
	%Deficit/surplus (+)	-31.47	-24.77	-20.43	-25.51	-14.04	-3.70	4.29	-4.43			
Average	DCP supplied (kg/h/d)	0.382^{a}	0.452^{b}	0.474^{b}	0.436^{x}	0.428^{b}	0.525^{c}	0.562^{c}	0.505^{y}	0.014	0.039	0.034
	%Deficit/surplus (+)	-26.32	-13.40	-9.87	-16.50	-18.62	-0.63	5.90	-4.41			
	TDN supplied (kg/h/d)	4.410^{a}	4.863^{b}	5.072^{b}	4.782^{x}	4.975^{b}	5.545^{c}	5.754^{c}	5.425^{y}	0.081	0.230	0.195
	%Deficit/surplus (+)	-17.87	-10.43	-7.79	-11.99	-9.72	0.10	2.74	-2.26			

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deficiency of 16.50 percent DCP and 11.99 percent TDN in FRG system. Lowest amount of nutrient received by the buffaloes of small farmers in FRG system during summer season as deficiency of 39.55 percent DCP and 31.47 percent TDN.

4.4.5 Milk Production of Livestock

Milk production of cows and buffaloes were recorded thrice in a season with the cooperation of farmers in selected villages (Table 12). The year wise mean yield of cows was 3.42 litre/day in managed feeding system, which was significantly higher than FRG mean yield (2.39 litre/day). The milk yield of the cows of FRG and MF system was similar during winter season, but the cows under MF system yielded significantly higher quantity of milk in monsoon and summer season (3.67 and 2.90 litre/day) as compared to the cows reared in FRG system (2.84 and 1.05 litre/day, respectively).

In FRG system the effect of land holding categories on milk yield of cows was not significant in monsoon and summer season, however, in winter season cows of large farmers produce significantly higher milk (3.80 litre/day) as compared to small (2.97 litre/day) and medium (3.05 litre/day) landholders. In managed feeding system the cows of large farmers yielded significantly higher quantity of milk through out the year (3.87 litre/day).

The mean yield of lactating buffaloes in FRG and MF system were 3.66 and 4.70 litre/day respectively. These values were significantly different ($P > 0.05$) for throughout the year except for winter season .The highest milk yield was observed in the buffaloes of large farmers (5.94 litre/day) in MF system during

Table 12 Daily milk production (litre/day) of the livestock in different feeding systems

Seasons	Free range grazing				Managed feeding system				SEM ±	CD at	5%
	Small	Medium	Large	Mean	Small	Medium	Large	Mean		FC	FS
Cows											
Monsoon	2.74	2.80	2.97	2.84^{x}	3.55^{b}	3.50^{b}	3.96^{c}	3.67^{y}	0.12	0.34	0.29
Winter	2.97	3.05	3.80^{b}	3.27	3.41	3.47	4.28^{b}	3.72	0.19	0.54	NS
Summer	0.86	1.08	1.20	1.05^{x}	2.45^{b}	2.88^{bc}	3.37^{c}	2.90^{y}	0.23	0.65	0.55
Average	2.19	2.31	2.66	2.39^{x}	3.14^{b}	3.28^{b}	3.87^{c}	3.43^{y}	0.18	0.51	0.43
Buffaloes											
Monsoon	3.80	4.02	4.26	4.03^{x}	4.36^{b}	4.72^{bc}	4.87^{c}	4.65^{y}	0.16	0.46	0.39
Winter	4.26^{a}	5.40^{b}	5.50^{b}	5.05	4.60^{a}	5.80^{b}	5.94^{b}	5.45	0.17	0.48	NS
Summer	1.65^{a}	1.88^{a}	2.15^{b}	1.89^{x}	3.30^{c}	4.22^{d}	4.53^{d}	4.02^{y}	0.21	0.45	0.38
Average	3.24^{a}	3.77^{ab}	3.97^{b}	3.66^{x}	4.09^{b}	4.91^{c}	5.11^{c}	4.70^{y}	0.17	0.48	0.41

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winter and lowest in FRG buffaloes of small farmers (1.5 litre/day) during summer. Categories of land holding also made significant difference in buffalo's milk production. Buffaloes of large and medium farmers in MF system yielded significantly higher quantity of milk (5.11 and 4.91 litre/day) as compared to buffaloes of small land holders (4.09 litre /day).

4.4.6 Feed intake of growing cattle

The mean dry matter intake of cattle heifers was 4.05 kg/h/d for a year and the DMI for monsoon, winter and summer season were 4.22, 4.57 and 3.36 kg/h/d, respectively (Table 13). The DMI of heifers was significantly different among farmers categories in winter season only, where large farmers fed their animals significantly higher DM (4.77 kg/h/d) as compared to small farmers (4.39 kg/h/d). The dry matter intake of cattle heifers in monsoon season was 4.91, 4.24 and 4.24 kg/h/d for the animals of small, medium and large category of farmers, respectively. The difference among the categories of the farmers was not significant. The maximum dry matter was fed by large farmers in winter season (4.77 kg/h/d) and minimum by small farmers in summer season (3.03 kg/h/d).

The intake of green fodder for growing heifers was observed maximum in monsoon season (5.51 kg/h/d), but heifers with large farmers received maximum green fodder in winter (5.60 kg/h/d). The heifers did not provide the green fodder during summer season by all the farmers.

The large farmers fed concentrates to the heifers in significantly higher amount (0.44 kg/h/d) through out the year as compared to small landholders (0.23 kg/h/d). The

Table 13 Dry matter intake (kg/d) of growing cattle

Season	Particular	Categories of farmers				SEM ±	CD 5%
		Small	Medium	Large	Mean		
Monsoon	Green fodder	5.64	5.48	5.41	5.51	0.28	NS
(July-Oct)	Dry fodder	2.85	2.90	2.81	2.85	0.21	NS
	Concentrate	0.30[a]	0.35[a]	0.46[b]	0.37	0.05	0.14
	Total (fresh basis)	8.79	8.73	8.68	8.73	0.42	NS
	DMI(kg/h/d)	4.19	4.24	4.24	4.22	0.30	NS
Winter	Green fodder	4.98[a]	5.46[b]	5.60[b]	5 35	0.16	0.45
(Nov-Mar)	Dry fodder	3.30	3.33	3.35	3.33	0.22	NS
	Concentrate	0.30[a]	0.35[a]	0.52[b]	0.39	0.07	0.20
	Total (fresh basis)	8.58	9.14	9.47	9.06	0.34	NS
	DMI(kg/h/d)	4.39[a]	4.57[a]	4.77[b]	4.57	0.13	0.36
Summer	Green fodder	0.00	0.00	0.00	0.00	-	-
(Apr-June)	Dry fodder	3.27[a]	3.27[a]	3.98[b]	3.51	0.23	0.65
	Concentrate	0.10[a]	0.23[ab]	0.34[b]	0.22	0.06	0.17
	Total (fresh basis)	3.37[a]	3.50[a]	4.32[b]	3.73	0.31	0.87
	DMI(kg/h/d)	3.03[a]	3.15[a]	3.89[b]	3.36	0.29	0.82
Average	Green fodder	3.54	3.65	3.67	3.62	0.24	NS
	Dry fodder	3.14	3.17	3.38	3.23	0.23	NS
	Concentrate	0.23[a]	0.31[a]	0.44[b]	0.33	0.07	0.20
	Total (fresh basis)	6.91	7.12	7.49	7.18	0.33	NS
	DMI(kg/h/d)	3.87	3.99	4.30	4.05	0.24	NS

Figures with different superscripts in a row differs significantly (P>0.05)
NS = Non significant difference

Table 14 Daily DCP and TDN supplied to growing cattle in different seasons

Seasons	Nutrients	Categories of farmers				SEM ±	CD 5%
		Small	Medium	Large	Mean		
Monsoon	DCP requir.(kg/h/d)	0.287	0.288	0.289	0.288		
	DCP supplied (kg/h/d)	0.195	0.202	0.217	0.205	0.009	NS
	%Deficit/surplus (±)	-31.93	-29.75	-24.99	-28.89		
	TDN requir.(kg/h/d)	2.440	2.460	2.480	2.460		
	TDN supplied (kg/h/d)	2.370	2.405	2.431	2.402	0.046	NS
	%Deficit/surplus (±)	-2.87	-2.26	-1.99	-2.37		
Winter	DCP requir.(kg/h/d)	0.293	0.296	0.296	0.295		
	DCP supplied (kg/h/d)	0.216[a]	0.233[a]	0.264[b]	0.238	0.007	0.020
	%Deficit/surplus (±)	-26.21	-21.35	-10.79	-19.45		
	TDN requir.(kg/h/d)	2.560	2.610	2.620	2.597		
	TDN supplied (kg/h/d)	2.475[a]	2.596[a]	2.745[b]	2.605	0.052	0.147
	%Deficit/surplus (±)	-3.32	-0.54	4.77	0.30		
Summer	DCP requir.(kg/h/d)	0.307	0.309	0.310	0.309		
	DCP supplied (kg/h/d)	0.103[a]	0.123[a]	0.159[b]	0.129	0.016	0.045
	%Deficit/surplus (±)	-66.29	-60.11	-48.66	-58.36		
	TDN requir.(kg/h/d)	2.750	2.880	2.900	2.843		
	TDN supplied (kg/h/d)	1.570[a]	1.670[a]	2.070[b]	1.769	0.097	0.274
	%Deficit/surplus (±)	-42.76	-42.18	-28.66	-37.87		
Average	DCP requir.(kg/h/d)	0.296	0.298	0.298	0.297		
	DCP supplied (kg/h/d)	0.172[a]	0.186[a]	0.213[b]	0.190	0.011	0.031
	%Deficit/surplus (±)	-41.48	-37.07	-28.15	-35.57		
	TDN requir.(kg/h/d)	2.583	2.650	2.667	2.633		
	TDN supplied (kg/h/d)	2.140[a]	2.222[a]	2.415[b]	2.259	0.065	0.183
	%Deficit/surplus (±)	-16.32	-14.99	-8.63	-13.31		

Figures with different superscripts in a row differs significantly (P>0.05)
NS = Non significant difference

year wise average intake of dry fodder was 3.16 kg/h/d, which was not differed significantly among the animals of different farmers.

4.4.7 DCP and TDN supply to growing cattle

The DCP and TDN requirement of growing cattle were calculated on the basis of their body weight as per recommendation of ICAR, 1985. Farmers adopted FRG system for most of the growing heifers in summer and part of monsoon season by all the categories.

The average DCP supply to the growing cattle in monsoon season was 0.205 kg/h/d, which was 28.89% less than the recommended requirement. The DCP supply was deficient throughout the year (Table 14). However, acute DCP deficit was observed in summer (-58.36%) as compared to the standard requirement. The maximum supply of DCP was in winter season (0.238 kg/h/d) and large farmers fed their growing cattle with significantly higher amount of DCP (0.264 kg/h/d) as compared to medium (0.233) and small landholders (0.216 kg/h/d).

The average TDN supply was comparatively better than DCP in growing cattle. The TDN supply in monsoon season was moderately deficit (-2.37%) but maximum deficiency of TDN was observed in summer (-37.87%). In winter season TDN supply was almost as per the requirement, however large farmers fed surplus TDN (4.77%) compared to small (-3.32%) and medium farmers (-0.54%).

4.4.8 Feed intake of growing buffaloes

The buffalo heifers were maintained in managed feeding system in winter and monsoon seasons and free range grazing was adopted in summer and part of monsoon

Table 15 Dry matter intake (kg/d) of growing buffaloes

Season	Particular	Categories of farmers				SEM ±	CD 5%
		Small	Medium	Large	Mean		
Monsoon	Green fodder	5.74	5.78	5.81	5.78	0.21	NS
(July-Oct)	Dry fodder	3.04	3.10	3.02	3.05	0.17	NS
	Concentrate	0.30 [a]	0.49 [b]	0.58 [b]	0.46	0.06	0.17
	Total (fresh basis)	9.08	9.37	9.41	9.29	0.32	NS
	DMI(kg/h/d)	4.38	4.62	4.63	4.55	0.15	NS
Winter	Green fodder	4.87 [a]	5.26 [b]	5.58 [b]	5.24	0.14	0.39
(Nov-Mar)	Dry fodder	3.52	3.46	3.41	3.46	0.20	NS
	Concentrate	0.35 [a]	0.77 [b]	0.88 [b]	0.67	0.09	0.25
	Total (fresh basis)	8.74 [a]	9.49 [b]	9.87 [b]	9.37	0.26	0.73
	DMI(kg/h/d)	4.60 [a]	5.02 [b]	5.14 [b]	4.92	0.12	0.34
Summer	Green fodder	0.00	0.00	1.25 [b]	0.42	0.15	0.42
(Apr-June)	Dry fodder	3.96 [a]	4.10 [a]	4.81 [b]	4.29	0.19	0.54
	Concentrate	0.40 [a]	0.61 [b]	0.68 [b]	0.56	0.06	0.17
	Total (fresh basis)	4.36 [a]	4.71 [a]	6.74 [b]	5.27	0.28	0.79
	DMI(kg/h/d)	3.92 [a]	4.24 [a]	5.02 [b]	4.41	0.13	0.37
Average	Green fodder	3.54 [a]	3.68 [a]	4.21 [b]	3.81	0.18	0.51
	Dry fodder	3.51	3.55	3.75	3.60	0.20	NS
	Concentrate	0.35 [a]	0.62 [b]	0.71 [b]	0.56	0.08	0.23
	Total (fresh basis)	7.39 [a]	7.86 [a]	8.67 [b]	7.97	0.29	0.82
	DMI(kg/h/d)	4.30 [a]	4.62 [ab]	4.96 [b]	4.62	0.14	0.39

Figures with different superscripts in a row differs significantly (P>0.05)
NS = Non significant difference

Table 16 Daily DCP and TDN supplied to growing buffaloes in different seasons

Seasons	Nutrients	Categories of farmers				SEM ±	CD 5%
		Small	Medium	Large	Mean		
Monsoon	DCP requir.(kg/h/d)	0.235	0.243	0.243	0.2403		
	DCP supplied (kg/h/d)	0.201[a]	0.234[b]	0.247[b]	0.227	0.006	0.017
	%Deficit/surplus (±)	-14.33	-3.82	1.49	-5.55		
	TDN requir.(kg/h/d)	2.220	2.250	2.250	2.240		
	TDN supplied (kg/h/d)	2.233[a]	2.396[b]	2.430[b]	2.353	0.037	0.104
	%Deficit/surplus (±)	0.59	6.51	7.99	5.03		
Winter	DCP requir.(kg/h/d)	0.268	0.276	0.280	0.275		
	DCP supplied (kg/h/d)	0.209[a]	0.280[b]	0.301[b]	0.270	0.012	0.034
	%Deficit/surplus (±)	-22.14	1.41	7.41	-4.44		
	TDN requir.(kg/h/d)	2.580	2.600	2.620	2.600		
	TDN supplied (kg/h/d)	2.524[a]	2.850[b]	2.953[b]	2.776	0.043	0.121
	%Deficit/surplus (±)	-2.16	9.63	12.73	6.73		
Summer	DCP requir.(kg/h/d)	0.323	0.326	0.331	0.327		
	DCP supplied (kg/h/d)	0.156[a]	0.191[a]	0.236[b]	0.194	0.014	0.039
	%Deficit/surplus (±)	-51.75	-41.37	-28.61	-40.58		
	TDN requir.(kg/h/d)	3.070	3.090	3.130	3.097		
	TDN supplied (kg/h/d)	2.100[a]	2.310[a]	2.850[b]	2.422	0.078	0.220
	%Deficit/surplus (±)	-31.54	-25.15	-8.91	-21.87		
Average	DCP requir.(kg/h/d)	0.275	0.282	0.285	0.281		
	DCP supplied (kg/h/d)	0.189[a]	0.235[b]	0.261[b]	0.230	0.011	0.032
	%Deficit/surplus (±)	-29.41	-14.60	-6.57	-16.86		
	TDN requir.(kg/h/d)	2.623	2.647	2.667	2.646		
	TDN supplied (kg/h/d)	2.286[a]	2.520[b]	2.745[b]	2.517	0.076	0.226
	%Deficit/surplus (±)	-11.04	-3.00	3.93	-3.37		

Figures with different superscripts in a row differs significantly (P>0.05)

season by all the categories of farmers. The mean dry matter intake of buffalo heifers was observed 4.62 kg/h/d for a year. The maximum DMI was in winter (4.92 kg/h/d) and minimum during summer season (4.41kg/h/d). Large farmers fed their animals comparatively higher amount of dry matter in winter (5.14 kg/h/d) as well as in summer (5.02 kg/h/d) as compared to small and medium categories of the farmers (Table 15).

Intake of green fodder was maximum (5.78 kg) in monsoon season, than in winter (5.24 kg) and minimum in summer season (0.42 kg/h/d). The significant difference in green fodder intake due to categories of farmers was observed in winter season where large farmers offered more green fodder (5.58 kg/h/d) compared to small landholders (4.87 kg/h/d). In summer season small and medium landholders could not find green fodder to feed their heifers.

The year wise mean dry fodder intake of buffalo heifers was 3.60 kg/h/d, which was not differed significantly among the animals of different landholders. Throughout the year very limited amount of concentrate was offered to buffalo heifers (0.56 kg/h/d) by all the farmers categories. However, large farmers offered significantly higher concentrate (0.71 kg/h/d) as compared to small landholders (0.35 kg/h/d).

4.4.9 DCP and TDN supply to growing buffaloes

The requirements of DCP and TDN for growing buffaloes were calculated as per ICAR, 1985 recommendations on the basis of their body weight. The average supply of DCP to buffalo heifers was 0.230 kg/h/d for a year, which was deficient to

standard requirement (-16.86%). The supply of DCP to buffaloes heifers was moderately deficient in monsoon (-6.55%) and winter (-4.44%) season. But supply of DCP was more deficits (-43.20%) in summer season as compared to standard requirements. Large and medium farmers fed their buffalo heifers significantly high amount of DCP as compared to small land holders through out the year 0.261, 0.235 and 0.189 kg/h/d, respectively (Table 16).

The average supply of TDN to buffalo heifers was 2.517 kg/h/d for a year, which was deficient to standard requirement (-3.37%). The TDN supply to the buffalo heifers was almost as per standard requirement in monsoon and winter season in all categories of the farmers. But in summer season TDN were fed with a mean deficiency of 21.87% than recommended level. Animals of large and medium categories of farmers received significantly higher amount of TDN as compared to small farmers in throughout the year. Maximum supply of TDN was observed in winter season for the heifers of large farmers (2.953 kg/h/d) and minimum in summer season for small landholders (2.100 kg/h/d).

4.4.10 Growth rate of heifers

The initial body weight (mean) of cattle and buffaloes heifers was 136±6.2 kg and 142±5.7 kg, respectively. The growth rate of cattle heifers was highest in winter season (231 g/day) than monsoon (219 g/day), but in summer season average growth was negative (-11 g/day). Cattle heifers lost their body weight in small (-25 g/day) and medium farmers categories (-17 g/day) during summer season. Annual average growth was significantly higher (P> 0.05) in cattle heifers of large farmers (166 g/day) as

Fig. 4 Growth rate of cattle heifers in different seasons under Three categories of farmers

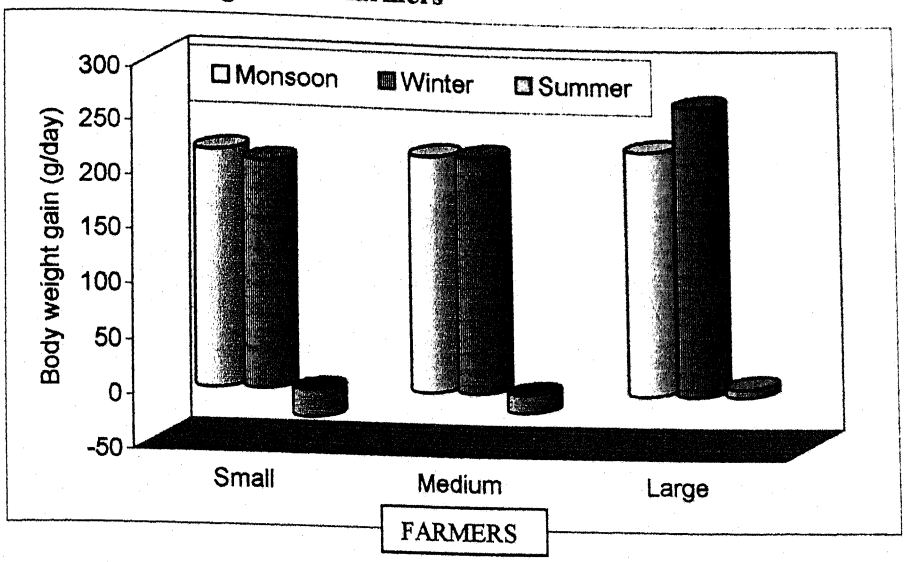
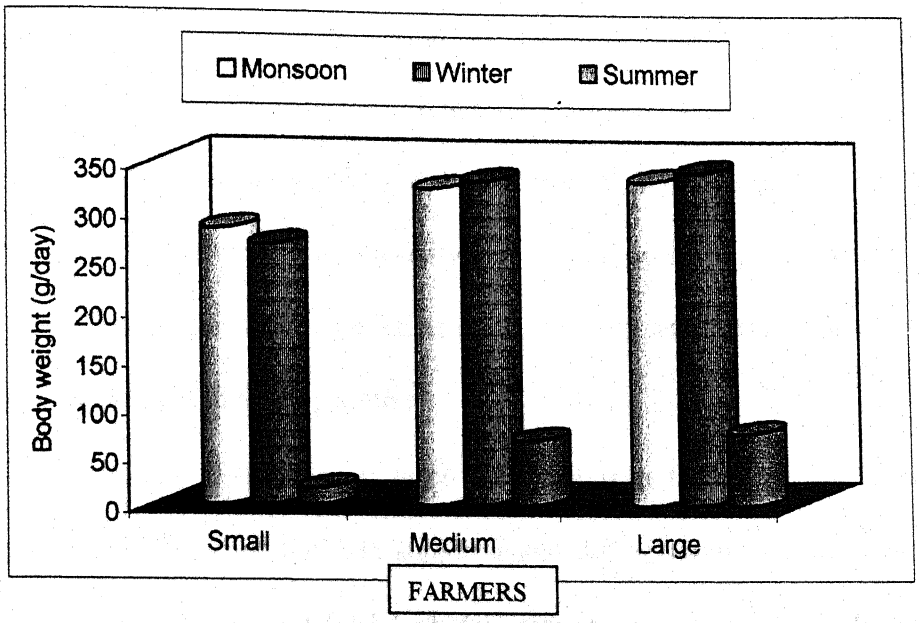


Fig. 5 Growth rate of buffalo heifers in different seasons under Three categories of farmers



compared to small (133 g/day) and medium farmers (139 g/day). Highest growth of cattle was observed in case of large farmers (267 g/day) during winter season.

The growth of buffalo heifers was similar in monsoon and winter season (314 g/day) whereas, lowest growth of buffaloes observed in summer season 53 g/day. Average growth of buffalo heifers for large and medium categories was 250 and 241 g/day, which was significantly higher than buffaloes of small farmers (189/day). Highest live weight gain was recorded in the buffaloes of large farmers (342 g/day) in winter season and lowest in the heifers of small farmers (17 g/day) during summer season

4.4.11 Feed intake of sheep

Feed intake of sheep was recorded for monsoon, winter and summer season in the animals of small and medium farmers. The large farmers were not rearing sheep in selected villages of Bundelkhand Region. Feeding practices adopted by the farmers for sheep was 6 to 8 hours grazing and supplemental feeding at house. The feed intake during grazing hours could not quantity due to grazing and lopping behavior of sheep. However feed intake was recorded as green, dry and concentrates feeds, which were supplemented as stall feeding at home.

The mean DM intake of sheep as supplemented at home was 0.51 kg/h/d as year average. However the feed supplemented during monsoon, winter and summer season was 0.47, 0.52 and 0.55 kg/h/day, respectively (Table 17). The average dry matter intake was almost similar in the sheep of small (0.50 kg/h/d) and medium landholders (0.52 kg/h/d). Medium category of farmers fed slightly higher amount of

Table 17 Supplementary feed intake (kg/d) of Sheep

Season	Particulars	Categories of farmers				SEM ±	CD 5%
		Small	Medium	Large	Mean		
Monsoon	Green fodder	0.11	0.10	NA	0.11	0.07	NS
(July-Oct)	Dry fodder	0.31	0.32	NA	0.32	0.10	NS
	Concentrate	0.17	0.18	NA	0.18	0.09	NS
	Total (fresh basis)	0.59	0.60	NA	0.60	0.14	NS
	DMI(kg/h/d)	0.46	0.47	NA	0.47	0.11	NS
Winter	Green fodder	0.20	0.21	NA	0.21	0.08	NS
(Nov-Mar)	Dry fodder	0.33	0.33	NA	0.33	0.12	NS
	Concentrate	0.19	0.20	NA	0.20	0.10	NS
	Total (fresh basis)	0.72	0.74	NA	0.73	0.13	NS
	DMI(kg/h/d)	0.51	0.53	NA	0.52	0.12	NS
Summer	Green fodder	0.12	0.11	NA	0.12	0.09	NS
(Apr-June)	Dry fodder	0.37	0.38	NA	0.38	0.13	NS
	Concentrate	0.20	0.22	NA	0.21	0.11	NS
	Total (fresh basis)	0.69	0.71	NA	0.70	0.15	NS
	DMI(kg/h/d)	0.54	0.56	NA	0.55	0.14	NS
Average	Green fodder	0.14	0.14	NA	0.14	0.08	NS
	Dry fodder	0.34	0.34	NA	0.34	0.12	NS
	Concentrate	0.19	0.20	NA	0.19	0.11	NS
	Total (fresh basis)	0.67	0.68	NA	0.68	0.14	NS
	DMI(kg/h/d)	0.50	0.52	NA	0.51	0.13	NS

NA = Not applicable (The sheep were not reared by the large farmers in the region)
NS = Non significant difference

concentrate (0.20 kg/h/d) to their sheep, compared to small landholders (0.19 kg/h/d). The maximum dry fodder was supplemented in the diet of sheep during summer season (0.34 kg/h/d) and maximum green fodder (0.21 kg/h/d) in winter season. Green fodder intake of sheep was not significantly different among animals of small and medium landholders throughout the year.

4.4.12 Feed intake of goat

Feed intake of goat was recorded as supplemented to them as stall fed at home excluding the quantity of feed intake during grazing hours. The mean dry matter intake of goat was 0.56kg/h/d as supplemented feed in the region. The average DM intake (kg/h/d) of goat in the small medium and large farmers was 0.55, 0.54 and 0.60 kg, respectively, which was not significantly different (Table18). The maximum dry matter intake of supplemented feed was recorded in the goats in summer season (0.59 kg/h/d) and minimum in monsoon season (0.52 kg/h/d). The annual mean of crop residue intake was almost similar for the goats of small, medium and large categories of the farmers 0.38, 0.38 and 0.39 kg/h/d, respectively. The average green fodder supplemented in the diet of goats was also not differed significantly among the categories of farmers. However, the maximum green fodder was supplemented to the goats in winter (0.24 kg/h/day) and maximum crop residues in summer (0.41 kg/h/d) by all the categories of the farmers.

The mean intake of concentrate was 0.20 kg/h/d in the region. However, large farmers supplemented significantly higher amount of concentrate (0.25 kg/h/d) to their goats as compared to small (0.18 kg) and medium farmers (0.19 kg/h/day). Maximum

Table 18 Supplementary feed intake (kg/d) of Goat

Season	Particulars	Categories of farmers				SEM ±	CD 5%
		Small	Medium	Large	Mean		
Monsoon	Green fodder	0.14	0.12	0.05	0.09	0.04	NS
(July-Oct)	Dry fodder	0.36	0.36	0.37	0.36	0.14	NS
	Concentrate	0.16[a]	0.17[a]	0.23[b]	0.19	0.02	0.05
	Total (fresh basis)	0.66	0.65	0.60	0.64	0.13	NS
	DMI(kg/h/d)	0.50	0.51	0.54	0.52	0.10	NS
Winter	Green fodder	0.21[a]	0.23[a]	0.28[b]	0.24	0.02	0.06
(Nov-Mar)	Dry fodder	0.39	0.38	0.38	0.38	0.12	NS
	Concentrate	0.18[a]	0.18[a]	0.24[b]	0.20	0.01	0 03
	Total (fresh basis)	0.78	0.79	0.90	0.82	0.15	NS
	DMI(kg/h/d)	0.56	0.56	0.62	0.58	0.09	NS
Summer	Green fodder	0.18	0.12	0.11	0.14	0.07	NS
(Apr-June)	Dry fodder	0.40	0.39	0.41	0.40	0.11	NS
	Concentrate	0.20[a]	0.21[a]	0.27[b]	0.23	0.02	0.05
	Total (fresh basis)	0.78	0.72	0.79	0.76	0.12	NS
	DMI(kg/h/d)	0.58	0.56	0.63	0.59	0.10	NS
Average	Green fodder	0.18	0.16	0.13	0.15	0.05	NS
	Dry fodder	0.38	0.38	0.39	0.38	0.12	NS
	Concentrate	0.18[a]	0.19[a]	0.25[b]	0.20	0.02	0.06
	Total (fresh basis)	0.74	0.72	0.76	0 74	0.14	NS
	DMI(kg/h/d)	0.55	0.54	0.60	0.56	0.10	NS

Figures with different superscripts in a row differs significantly (P>0.05)
NS = Non significant difference

concentrate was supplemented to goats in summer season by large farmers (0.27 kg/h/d), and minimum in monsoon season by small farmers (0.166 kg/h/day). Grazing hours for goat was similar (6 to 8 hours) in small medium and large categories of the farmers.

4.5 Economics of Both the Feeding System

4.5.1 Economics of milk production of cows in the region

Economics of milk production was work out on the basis of present rates of input/output prevailing in the region, for the cows under different feeding system and different categories of the farmers. The total input cost of rearing a cow was Rs. 6560/year under FRG system and Rs. 10591/year under MF system in the region. On the basis of categories of the farmers minimum expenditure was made by small farmers (Rs. 5935/cow/year) in FRG system and maximum by large farmers (Rs. 12024 /cow/year) in managed feeding system (Table 19).

The total income from sale of products was higher in managed feeding system (Rs. 14550/cow/year) as compared to FRG system (Rs. 10125/cow/year). But the net income for FRG and MF system was Rs. 3565 and Rs. 3959 /cow/year, respectively in the selected villages. The net income was highest to large farmers in managed feeding system (Rs. 4136/cow/year) and lowest to small farmers in FRG system (Rs. 3460/cow/year).

The cost of milk production was higher in the cows of managed feeding system (Rs. 8.46/litre) as compared to FRG system (Rs. 7.52/litre). The lowest cost of milk production for FRG system was in the cows of small farmers (Rs.7.43/litre) and

Table 19 Economics of milk production of cows for different feeding systems

Particulars	Free range grazing *(Anna Pratha)*				Managed feeding system			
	Small	Medium	Large	Mean	Small	Medium	Large	Mean
Estimated cost of animal (Rs)	2000	2200	2500	2233	2500	2500	3000	2667
Interest @ 12% p/a (Rs)	240	264	300	268	300	300	360	320
Feeds (quintal/ year)								
Cultivated fodder	0.00	3.64	3.87	3.69	7.34	7.70	8.41	7.81
Crop residue/ Dry fodder	14.93	14.78	14.86	14.86	17.52	17.48	17.92	17.63
Concentrates	3.36	3.61	4.75	3.91	4.75	5.00	6.50	5.40
Cost of feed (Rs/year)	3545	3912	4723	4125	5127	5323	6444	5621
Laborers								
Labour days/ year	30	30	30	30	62	62	72	65
Labour cost (@ Rs 60/ day)	1800	1800	1800	1800	3720	3720	4320	3900
Othercost (Housing, veterinary etc)	350	350	400	367	600	750	900	750
Total cost (Rs/ cow/ year)	5935	6326	7223	6560	9747	10093	12024	10591
Production								
Milk (Litres / year)	799	843	971	872	1146	1197	1413	1252
Price of milk @ Rs 10/lit	7990	8430	9710	8720	11460	11970	14130	12520
Dung (ton/ year)	3.60	3.60	3.60	3.60	5.40	5.40	5.40	5.40
Price of dung @ Rs 300/ton	1080	1080	1080	1080	1620	1620	1620	1620
Price of Calve	325	325	325	325	410	410	410	410
Total Income (Rs/ cow / year)	9395	9835	11115	10125	13490	14000	16160	14550
Net income (Rs/ cow / year)	3460	3509	3892	3565	3743	3907	4136	3959
Cost of Milk production (Rs/Litre)	7.43	7.50	7.44	7.52	8.50	8.43	8.51	8.46

Average rate of cultivated fodder, crop residues and concentrate was Rs 55, 80 and 700 per quintal, respectively in the villages.

in managed feeding system it was lowest for medium farmers (Rs. 8.43). The highest cost of cows milk production was Rs. 8.51/litre for the large farmers adopted managed feeding system. However productivity of milk was higher in managed feeding system (1252 litre/cow/year) as compared to FRG system (872 litre/cow/year).

4.5.2 Economics of milk production of buffaloes in selected villages

Economics of milk production for buffaloes were work out for FRG and MF system for three categories of landholders on the basis of present rates prevailing in the region (Table 20). The total cost of rearing a buffalo was lower (Rs. 10750/year) in FRG system as compared to MF system (Rs. 14739 /year) in the region. The total cost of rearing a buffalo under managed feeding system was highest in case of large farmers (Rs.16018/buffalo/year) than in medium (Rs. 15115/buffalo/year) and lowest in small farmers (12753/buffalo/year). Similar trend was observed in FRG system and total cost for small, medium and large farmers were Rs. 9801, 11022 and 11433/buffalo/year, respectively. The cost of feed contributed maximum part of total cost of rearing buffalo in the regions.

Total income from a buffalo was higher in managed feeding system (Rs. 23159/year) as compared to FRG system (Rs. 17842/year). However, net income from MF system (Rs. 8420/buffalo/year) was higher as compared to and FRG system (Rs. 7092/buffalo/year). Maximum net income received by the medium categories of farmers adopted managed feeding system (Rs. 8960/buffalo/year) and minimum by small farmers adopted FRG system (Rs. 6216/buffaloe/year).

Table 20 Economics of milk production of buffaloes for different feeding systems

Particulars	Free range grazing *(Anna Pratha)*				Managed feeding system			
	Small	Medium	Large	Mean	Small	Medium	Large	Mean
Estimated cost of animal (Rs)	9000	10000	10000	9667	10000	11000	12000	11000
Interest @ 12% p/a (Rs)	1080	1200	1200	1160	1200	1320	1440	1320
Feeds (quintal/ year)								
Cultivated fodder	7.02	7.72	8.26	7.67	10.51	12.92	13.82	12.42
Crop residue/ Dry fodder	16.04	16.47	16.97	16.47	21.83	21.72	21.54	21.68
Concentrates	5.44	7.01	7.37	6.61	6.21	8.40	9.31	7.96
Cost of feed (Rs)	5476	6648	6973	6364	6668	8325	8998	7987
Laborers								
Labour days/ year	61	61	61	61	86	94	96	94
Labour cost (@ Rs 60/ day)	3660	3660	3660	3660	5160	5640	5760	5640
Other cost (Housing, veterinary etc)	425	450	500	458	625	850	900	792
Total cost (Rs/ buffalo / year)	9801	11022	11433	10750	12753	15115	16018	14739
Production								
Milk(Litres/year)	1183	1375	1449	1335	1492	1793	1866	1717
Price of milk @ Rs 12/ lit	14196	16498	17389	16021	17900	21520	22396	20605
Dung (ton/year)	4.32	4.32	4.32	4.32	6.48	6.48	6.48	6.48
Price of dung @ Rs 300/ ton	1296	1296	1296	1296	1944	1944	1944	1944
Price of Calve	525	525	525	525	610	610	610	610
Total Income (Rs/ buffalo / year)	16017	18319	19210	17842	20454	24074	24950	23159
Net income (Rs/ buffalo / year)	6216	7297	7776	7092	7701	8960	8932	8420
Cost of Milk production (Rs/Litre)	8.29	8.02	7.89	8.05	8.55	8.43	8.58	8.58

Average rate of cultivated fodder, crop residues and concentrate was Rs 55, 80 and 700 per quintal, respectively in the villages.

The cost of milk production was higher in managed feeding system (Rs. 8.58/litre) as compared to buffaloes under FRG system (Rs. 8.05/litre). The lowest cost of milk production in managed feeding system was for medium category of farmers (Rs. 8.43/litre) and in FRG system, it was lowest (Rs. 7.89/litre) for large categories of farmers.

The milk productivity of a buffalo was higher in managed feeding system (1717 litre/year) as compared to FRG system (1335 litre/year). The productivity of milk increased with increase in size of land holdings of farmers in both the feeding systems.

CHAPTER V

DISCUSSION

The main objectives of present study were to assess the feed resources availability, their nutritional value and comparative analysis of both feeding systems (FRG and MF) prevailing in the Bundelkhand region. Findings of the study are discussed on the following major points:

- Socio-economic status of livestock farmers in the region
- Livestock resources
- Feed resources availability and nutritional evaluation
- Comparative analysis of both feeding systems for major livestock
- Economics of both feeding system

5.1 Socio-Economic Status of Livestock Farmers in the Region

Data were obtained from ten representative villages of Bundelkhand region. Majority of the sample farmers (56%) were in middle age group (35-60 years), and 30% were young (below 35 years), and only 14% forms were old (above 60 years). The reason of maximum number of old aged farmers (22%) in the large land holding category were undivided families under the leadership of senior most person. Results

on educational status of the farmers reveled that maximum farmers were educated up to primary standard (46.7%) or illiterate (36%), whereas 12.7 percent farmers passed high school and 4.67 percent (mainly from large land holding category) were Graduate. The literacy status of the farmers increased with increase in land holding in the region. The reasons for high literacy in large farmers were more availability of resources and awareness for education, on other hand maximum number of illiterate farmers were from small and medium landholders. Average land holding for small, medium and large farmers were 1.26, 2.86 and 6.19 ha/family. The irrigated land was more with large farmers, whereas resource poor small and medium farmers have limited irrigation facilities.

5.2 Livestock Resources of the Region

Data of livestock from 150 sample household revealed that buffaloes were the maximum reared livestock (32.06%) than cattle (29.98%), goat (2.5.58%) and sheep (12.88%) in the region. The livestock distribution in different categories of farmers showed that average number of buffaloes was higher with large (4.94/family) and medium farmers (3.84/family), mainly for milk production purpose whereas cattle were higher with small (3.74/family) and medium farmers (3.64/family), mainly for milk and draught purposes. Sajjan Sihag *et al* (2002) also reported that average number of cattle /family was higher in small farmers while buffalo/family was higher with large farmers in Haryana. Sheep and goats mainly reared by the small and medium landholders, due to low input and quick return. Large farmers were reluctant to rear sheep due to lack of family labor or some social reasons.

The maximum numbers of livestock ACU were reared by medium farmers (7.84 ACU/family) against large farmers (6.78 ACU/family) so that they compensate the income of crop production as well as draught power required for agricultural operations. The livestock ACU was found 4.83, 2.57 and 1.09/ha land for small, medium and large categories, respectively. Maximum pressure of ACU was noticed on the land of small farmers due to less land holding (1.16 ha/family). The pressure of ACU was decreased with increase in size of land holding (Tyagi, 1997).

The comparison of total livestock population in the year 1985 and year 2001 showed the negative growth (-4.10%) of livestock in the region. The major decline was observed in cattle population (-9.36%), especially male cattle decreased by 4.59 percent. This decline might be due to mechanization of agricultural operations. The farmers rearing animals mainly for milk production purpose, therefore population of buffaloes increased (3.15%) in the region. The population of goat and sheep were moderately increased from the year 1985 to 2001 in the region. Cattle were mostly reared by the small and medium categories and majority of the farmers in the Bundelkhand region are small and marginal landholders (IGFRI, 1992).

Tyagi (1997) recommended maximum animal density for the type of land found in the region is 0.78 ACU/ha, whereas huge number of animals existing with the farmers (3.08ACU/ha) in the selected villages. The govt. of UP (1991) reported that the dependence of people on livestock was reinforced due to poor agricultural productivity on account of large numbers of small and medium holdings. Poor

resource base and low cropping intensity of about 113 percent might be the factors for high animal pressure in the region.

5.3 Feed Resources

5.3.1 Feed resources availability in the region

The analysis of data related to feed resource availability and requirement showed that about 20 percent fodder was deficit in the sample villages. The major deficit was found from concentrate (- 44.9%) whereas in the case of roughage it was only 7.19 percent on dry matter basis. Large farmers possessed surplus amount of fodder roughage (+ 40%) and concentrate (+ 9.3%), whereas small farmers faced acute deficit of fodder roughage (- 37.6%) and concentrate (39.8%) for their livestock in the region.

Crop residues were the major source of roughage supply and lowest amount of roughage received from cultivated fodder in the region. The main reason behind less area under fodder cultivation were (i) lack of irrigation facility, (ii) prevailing system of free range grazing and (iii) lack of motivation and suitable fodder production technologies Saran et al (2000) also reported similar observation in Bundelkhand region.

The deficit of feed resources in semi arid regions was also reported earlier (Hampiah, 1981; Punj and Devendra, 1988; Mudgal *et al* 1988; Ravindran and Devendra, 1988; Tripathi, 1991; Roggero *et al* 1996).

Forage received from grazing on forest land/wasteland was the second largest roughage sources after crop residues in the region. Such finding also reported in Bundelkhand region by earlier workers (Singh *et al*, 1995; Singh *et al*, 2001).

5.3.2 Nutritional evaluation of feed resources

The nutritive value of locally available feed resources as crop residues, cultivated fodder, concentrate and naturally grown grasses were evaluated. The crop residues available with the farmers were mainly straws of cereal and pulse crops. The CP content in crop residues varied from 3.42 to 14.86 percent. The straws of cereal crops like wheat, paddy, barley and lentil contained the CP in the range of 3.42 to 4.37 percent. However the CP content was found higher in residues of leguminous crop viz., moongbean straw (12.8%), chickpea straw (10.2%) and soyabean straw (14.8%). The CP content and other chemical constituent of crop residues were almost similar as reported earlier (Sen and Ray, 1971; Desai *et al* 1988; NRC, 1988).

The anti-nutritional factor lignin content was ranged from 5.98 to 9.93 percent and IVDMD from 36.54 to 61.92 percent in different crop residues. The lowest IVDMD (36.54%) was found in lentil straw might be due to highest lignin content (9.93%). Lignin is negatively correlated with digestibility (Lapierre, 1993; Buxton and Fales, 1994; Dzowela et al, 1995). Highest digestibility (61.92%) of pigeon pea straw might be due to high proportion of leaves in that straw.

The main cultivated fodder crops were sorghum and maize in *kharif* and berseem and oat in *Ravi* season. The sorghum and maize fodder contained fair amount of CP 7.70 and 8.40 percent, respectively to maintain the livestock. Berseem is the

rich source of CP (16.75%) and grown as major fodder crop by the dairy farmers. The oil cakes and cereal grains were the main concentrate available with the farmers. The high CP content was observed in oil cakes ranges from 26.8 to 39.1 percent. Cell wall fraction was lower in all the concentrates. IVDMD of concentrate were very high and ranged from 78.56 to 84.38 percent on DM basis. Chemical composition and IVDMD of these concentrate and cultivated fodder crops were in agreement to other reports (Sen and Ray, 1971; NRC, 1988).

All the species of naturally grown grasses contained the CP in the range of 3.92 to 7.60 percent, minimum in *Chrysopogon fulvus* and maximum in *Cynodon dectylon*, respectively. The lignin content was in the range of 5.92 to 7.6 percent and IVDMD varied from 48 to 60 percent. The CP content of these grasses were found comparable with earlier reports ((Sen and Ray, 1971; NRC, 1988).

5.3.3 Nutritional evaluation of shrubs and tree leaves

All the shrubs and tree leaves possessed high CP throughout the year (9.65 to 18.75%). Chemical compositions of these leaves are comparable with the results of Negi et al, (2003). Season wise analyses showed that CP content was higher in monsoon and summer season and moderately decline in winter season in all the shrubs and tree species. The similar trend of CP content of tree leaves was observed by Majumdar at al, (1988).

The cell wall fraction (NDF and ADF) increased with the maturity of leave and varied with the season. All the shrub species invariably exhibited lower content of NDF and ADF in summer or monsoon, at the time of emergence of new leaves. The

cell wall fraction remain lower during summer and maximum in winter when leaves mature (Negi at al, 2003).

The lignin (ADL) content in the leaves of all the shrubs species ranged from 4.8 to 14.5 percent, which was comparatively lower in monsoon and increased in the winter season with the maturity of leaves. Similarly, IVDMD values of tree leaves were higher in monsoon than summer and lowest in winter season. Lignin is the component most negatively correlated with degradability (Lapierre, 1993; Buxton and Fales, 1994; Dzowela et al, 1995).

Lower dry matter digestibility of *Madhuca indica*, *Ficus religiosa*, *Flacouritia indica* leaves might be due to presence of higher lignin content in these species. The mean IVDMD of shrubs and tree leaves was varied from 43.68 to 71.90 percent. These values are in agreement with earlier reported degradability (38 to 78) percent of shrubs and tree leaves (Skarpe and Bergstrom 1986).

Higher cell wall fraction and lower IVDMD was observed in winter season, when leaves matured. Digestibility may be negatively related to ADF content of forage (Albrecht and Broderich, 1990). The results of shrubs and tree leaves evaluation are also in the confirmation of the earlier reports on shrubs and tree leaves (Singh, et al, 1988; Singh et al, 1999; Ramana et al, 2000).

The results of present evaluation of shrubs and tree leaves showed that these species are potential source of nutrient supply to supplement in the diet of ruminants especially during lean period.

5.4 Comparative Analyses of Free Range Grazing and Managed Feeding Systems

The lactating cattle land buffaloes were reared under both the feeding systems in the region. However most of the growing cattle and buffaloes were reared under FRG system during summer and part of the monsoon season. Sheep and goat were also reared in FRG system from April to September. The major parameters taken for the comparison of both the systems were feed intake, nutrient availability (surplus/deficit), milk production and economics of production.

5.4.1 Feed intake of lactating cows

Data about the quantity of feed and fodder offered were obtained with a fair degree of precision, with the cooperation of farmers. Three types of feeds i.e. green fodder, dry fodder and concentrates were being fed to the milch cows (Table 8).

The annual average of dry matter intake (DMI) of milch cows was higher in MF system (6.81 kg/h/d) as compared to FRG system (5.70 kg/h/d), in the region. The feed intake was similar among animals of different landholders in FRG system, however in MF system large farmers fed their animals with higher amount of feed compared to small and medium landholders.

The average body weight of milch cows of MF and FRG was 343 and 329 kg, respectively. The DMI was less than requirement of 6 to 8 kg (ICAR, 1985) in FRG system. The major decrease of DMI in summer season might be due to poor availability of feed resource in summer season. This indicates that feeding care was better in MF system especially by the large farmers owing to more feed resource

available with large holding. Increase in feed intake of animals with the increase in size of land holdings of farmers was also reported by Patange *et al* (2002).

The green fodder included locally available green grasses, edible weeds from cropped land and cultivated fodder as green maize, oat and beerseem. The maximum intake of green fodder by milch cows was observed in monsoon season as average of both the feeding system (6.6 kg/h/d) followed by winter (5.7 kg/h/d), and lowest in summer season. However cows under FRG system could not received green fodder during summer season.

Contrary to our results, maximum green fodder intake was reported in winter season (Patel *et al*, 1982; Patange *et al*, 2002) for other climatic zones. The less area under cultivated fodder and limited irrigation facilities adversely affect the green fodder availability in winter season. The average green fodder intake of animals was adjusted according to seasonal availability (Badal and Dhaka, 1998).

The feed intake of milch cows in FRG and MF system was differed significantly in summer and monsoon season. But, in winter season DMI of milch cows was similar in FRG and MF system (6.98 and 7.07 kg/h/d) respectively). Free rage grazing of cows did not exist in winter season (Gomez *et al*, 1998).

The amount of concentrate feeding increased upward with increase in land holdings of the farmers, in MF system. The amount of concentrate, fed through out the year by the dairy farmers in the area, was 1.48 and 1.07 kg/h/d in MF and FRG system respectively. The ratio of roughage and concentrate was found uneven in the both feeding systems which might be due to high cost of concentrate.

5.4.2 Feed intake of lactating buffaloes

The year wise study of dry matter intake by milch buffaloes was significantly higher (8.75 kg/h/d) in MF system as compared to FRG system (7.75 kg/h/d). The mean DMI of MF buffaloes in monsoon, winter and summer seasons were 8.80, 9.06 and 8.39 kg/h/d which were sufficient to meet the DM requirement of 8-10 kg/h/d (ICAR, 1985). But in FRG system, buffaloes get DM below the requirement in monsoon (7.73 kg/h/d) and summer season (6.52 kg/h/d) due to less availability of feed resources in free range grazing. The DMI buffaloes were similar in all the farmers categories in FRG system but in MF system, large and medium farmers offered higher quantity of feed to their milch buffaloes compared to small farmers, because of more feed resource available to them due to large cropping land.

The DMI of MF buffaloes are comparable to report of Udeybir *et al*, (2000). The farmers categories wise, DMI of buffaloes are comparable with milch *Marathwadi* buffaloes of Maharastra region (Patange *et al*, 2002). In winter season, FRG buffaloes were not allowed for free range grazing and fed as managed feeding system, therefore DMI of buffaloes were similar in FRG and MF system (9.012 and 9.41 kg/h/d respectively) in winter season.

The maximum green fodder intake of buffaloes was recorded in monsoon season because of availability of monsoon grasses and edible weeds from cropped area and wasteland. However large and medium farmers fed higher quantity of green fodder in winter season, mainly berseem to their milch buffaloes due to availability of irrigation. The average green fodder intake was adjusted according to its seasonal

availability (Badal land Dhaka, 1998). The average quantity of green fodder intake of buffaloes is lower than reported in Haryana (Sihag *et al*, 2002), which might be due to regional variation more particularly soil fertility, better irrigation facility and awareness.

The dry fodder consisted of mainly crop residues, like wheat straw, sorghum *kadbi* and straws of leguminous crop as moong, urd, gram soyabeam etc. Crop residues were the major source of dry matter (66.9%) in total ration of buffaloes during summer season. Ranjhan, (1999) has also reported that about 50-60 percent of DMI in large ruminant comes through crop residues only and Pantage *et al*, (2002) reported 64.4 percent of crop residues in total ration of buffaloes.

The concentrate feeding to milch buffaloes was higher in summer season due to remunerative price of milk. Handa and Gill (1989) also reported maximum feeding of concentrate during March-May. Buffaloes under MF system were fed higher amount of concentrate (2.18 kg/h/.d) than FRG system (1.81 kg/h/d). The large and medium farmers fed 2.55 and 2.30 kg/h/d concentrate to their milch buffaloes against 1.70 kg/h/d by small landholders might be due to higher cost of concentrate. The quantity of concentrate feeding to milch buffaloes in Bundelkhand region are comparable with the findings of Patange *et al* (2002), who reported concentrate feeding of 2.16 kg/h/d in *Marathwari* buffaloes. But, lower than *Murrah* buffaloes (3.46 kg/h/d) of Haryana (Sihag *et al* 2002) which might be due to financial constraints of the farmers. Overall data revealed that buffaloes under MF system were

fed comparatively better than FRG system and feed supply to the milch buffaloes raised with increased land holding of the owners.

5.4.3 Nutrient availability to milch cows in different feeding systems

The plane of nutrition of milch cows was assessed in terms of digestible crude protein (DCP) and total digestible nutrients (TDN). The supply of DCP and TDN to the milch buffaloes was compared with standard requirements (ICAR, 1985) for both the feeding system.

Milch cows under MF system were fed round the year with higher DCP and TDN (0.354 and 4.116 kg/h/d) as compared to cows under FRG system (0.315 and 3.959) kg/h/d), due to higher dry matter intake and concentrate supply in MF system. The average supply of DCP and TDN to milch cows in MF system was almost equal to standard requirement (ICAR, 1985). However, cows under FRG system were faced deficit of 20.7% DCP and 14.7 %TDN, due to feeding of less quantity of green fodder and concentrate to FRG cows.

Acute nutrient deficit (- 46% DCP and –36% TDN) in FRG cows during summer season was due to non- availability of green fodder limited quantity of concentrate feeding and major supply of poor quality crop residues during summer season. Thus, farmers maintaining low to medium yielding cows in FRG system need to augment the nutrient supply by providing more of greens, concentrate of dry roughage to support the production potential of cows.

5.4.4 Nutrient availability of milch buffaloes in different feeding systems

Daily DCP and TDN supplied to milch buffaloes in different feeding systems (Table 10) were compared with standard feeding recommendations (ICAR, 1985). The buffaloes under FRG system received recommended level (ICAR , 1985) of DCP and TDN, even surplus amount of DCP (+ 5.90%) and TDN (+ 2.74%) in case of large farmers. But the buffaloes under FRG system received deficit amount of DCP (-16.50%) and TDN (-11.99%) due to lower feed intake specially green fodder and concentrate.

Patange *et al*, (2002) also surveyed ration of buffaloes and reported deficit of DCP and TDN 10.8 and 5.8 percent in Marathwada region. Lowest amount of nutrient received by the FRG buffaloes during summer season due to feeding of crop residues as a major part of feed, especially by the small landholders in Bundelkhand region. Such feeding of animals under village conditions has also been reported for Hisar region (Lal *et al*, 1995) and rural areas of Azamgarh district in Uttar Pradesh (Singh et al 1998).

Among season, maximum level of DCP was supplied during summer in MF system, and medium farmers fed surplus amount of DCP (13.4%) through concentrate, might be due to remunerative price of milk during summer season. Handa and Gill (1989) also observed highest supply of DCP in summer season than rest of the year.

On the basis of above observations there is a need to increase the nutrient supply to FRG buffaloes by providing more of green fodder and concentrate to support the production potential and get the optimum production.

5.4.5 Milk production

Milk production of cows and buffaloes in 24 hours recorded thrice in a season, with the cooperation of the farmers. The average milk yield of cows fed under MF system was 3.42 litre/day against 2.39 litre/day in FRG system. The milk yield of FRG cows in winter season was similar to cows in MF system (3.41 and 3.72 litre/day), whereas FRG cows were low producer for rest of the seasons. These results might be due to the free grazing cows received the nutrient supply less than the recommended level (ICAR 1985) throughout the year, except in winter season. The cows of large farmers in MF system produced highest quantity of milk (3.87 litre/day) throughout the year, due to constant supply of DCP and TDN.

The average milk yield of buffaloes was also higher in MF system (4.66 litre/day). The average milk production of cattle and buffaloes of Bundelkhand region found lower than milk yield of cattle and buffaloes in Haryana as 5.61 and 5.81 kg/day, respectively (Sajjan Sihag et al, 2002).

The highest milk yielded by the buffaloes of large farmers (5.94 litre/day) in MF system during winter and lowest in FRG buffaloes of small farmers (1.5 litre/day) during summer. The categories of farmers also made significant difference in milk production. The average milk yield of cattle and buffaloes was higher in the animals of large farmers than small farmers. Such findings also reported by Sajjan Sihag *et al*, (2002). Season wise, milk yield of cows and buffaloes was increased or decreased as per the feed supplied by the owners. Green fodder and concentrate contribute

possibility and significantly to the milk yield of both for cows and buffaloes (Shalander *et al*, 1994, Deepak shah *et al*, 1995).

Data of milk production clearly indicated that buffaloes yielded higher milk than cows in the region. Buffaloes were better maintained in MF system by large as well as medium farmers, while cows by large farmers only. Cows with small and medium landholders produced lower quantity of milk, especially in summer season. Low producing cows and buffaloes in FRG system need supplementation of nutrient through green fodder and concentrate to support their production potential.

5.4.6 Feed intake of growing heifers

The cattle and buffalo heifers were maintained in managed feeding system during winter season and in free range grazing during summer and part of monsoon season by all categories of the farmers.

The mean dry matter intake of cattle heifers was 4.05 kg/h/d throughout the year. The DMI was highest in winter (4.57 kg) than monsoon (4.22 kg) and lowest in summer season (3.36 kg/h/d) as per the seasonal availability of feed resources. Large farmers fed their cattle and buffaloes heifers with higher amount of dry matter might be due to more availability of feed resources.

In monsoon and summer season, the DMI of cattle and buffalo heifers was lower than the standard feeding (ICAR,1988; Pathak 1988) due to free range grazing by all the animals. Animals with small landholders received lowest DMI due to limited supplementary feeding by their owners. High roughage and low concentrate in the diet may also limit the feed intake. Positive correlation were observed between

dietary concentrate content and the percent DMI in straw based diet in both growing cattle and buffaloes (Udeybir, *et al*, 2000).

Dry roughage or crop residues were the major sources of feed for growing animals throughout the year due to less availability of green fodder in the region. Average amount of concentrate feeding was higher for buffaloes (0.56 kg/h/d) than cattle heifers (0.33 kg/h/d), might be due to higher market value of buffalo heifers. The feeding of concentrate increased with increase in landholding of owners might be due to high cost of concentrate.

5.4.7 DCP and TDN supply of growing animals

The supply of DCP and TDN to growing cattle and buffaloes heifers was compared to standard requirements (ICAR, 1985) on the basis of their body weight. The average DCP and TDN supply to growing cattle were 0.190 and 2.259 kg/h/day in the region, which was deficit by 35.5 and 13.3 percent respectively. However acute deficit of DCP (-58.3%) was observed in summer season. Buffaloes were fed better than cow heifers in the region. The average DCP and TDN supply of growing buffaloes were deficit only 16.8 and 3.4 percent as compared to standard requirements.

The maximum deficit of DCP and TDN was observed in summer season with all the categories of the farmers because most of the green fodder and concentrate available with the farmers were usually fed to lactating animals.

The deficit of DCP and TDN observed when animals were fed on poor quality roughage based diet (Pradhan, 1994). The average TDN supply was comparatively better than DCP in growing cattle and buffaloes. The nutrient supply to cattle and

buffaloes heifers at village level were found lower than pooled data of different trials at different experimental stations in India (Udeybir *et al*, 2000).

Nutrient supply to buffaloes were comparatively better than cattle heifers in the villages might be due higher sale value of buffalo heifers in the region.

5.4.8 Growth rate of heifers

The initial body weight (mean) of cattle and buffalo heifers was 136±6.2 kg and 142±5.7 kg, respectively. The growth rate of cattle heifers was highest in winter season (231 g/day) than in monsoon (219 g/day) but in summer reason average growth was negative (-11 g/day). Cattle lost their body weight in small (-25 g/day) and medium categories of the farmers (-17 g/day), during summer season. The feed intake and nutrient supply to the cattle heifers in different season was deficit which, might be the season for such growth. Live weight gain of cattle heifers with large farmers was significantly higher as compared to the animals of small and medium categories, due to higher amount of nutrient supply by the large farmers to their growing cattle.

The average growth of buffaloes heifers was similar in monsoon and winter season (314 g/day) whereas, lower growth rate of buffaloes was observed in summer season (53 g/day). The growth rate of buffaloes for large and medium categories was 250 and 241 g/day, which was higher than buffaloes of small farmers (189 g/day). The normal growth rate of heifers assumed 300 to 500 g/day for cattle and 400 g/day for buffalo heifers and nutrient intake through feed highly correlated with growth performance (ICAR, 1985; NRC, 1988; Pathak, 1988; Udeybir, 2000).

The growth rate of buffalo heifers was better than cows in the region but lower than standard growth. Cattle heifers of small and medium farmers lost their body weight during summer season might be due to deficit nutrient supply during free range grazing in summer season.

5.4.9 Feeding pattern of sheep and goat in the region

Feed intake of sheep and goat was recorded in different seasons for the animals of all categories of the farmers. The large farmers were not rearing sheep in the region might be due to some social reasons. Feeding practices, adopted by the farmers for sheep and goat, were grazing on wasteland or forestland and supplemental feeding at home. The grazing hours for sheep and goat were similar as 6 to 8 hours for small, medium and large categories.

The average supplementary feeding to sheep was similar in small (0.50 kg DM/h/d) and medium (0.52 kg DM/h/d) landholders. However medium categories of farmers supplemented moderately higher amount of concentrate to their sheep might be due to availability of more resources. The average dry matter supplemented to goat by small, medium and large farmers was 0.55, 0.54 and 0.60 kg/h/d, respectively. The concentrate was maximum supplemented to goat in summer season by large farmers (0.27 kg/h/d) and higher amount of crop residues was also supplemented in summer (0.41 kg/h/d) by all the categories of the farmers.

The mean body weight of adult sheep and goat were found 31.95±3.21 kg and 30.20±5.74 kg, respectively. The feed intake of sheep and goat in the region was sufficient to meet their requirement (ICAR, 1985). However moderate deficit of DM

in the goat of small farmers needs to be supplemented with concentrate. Goats potential is not often exploited fully due to lack of appropriate feeding (Pachauri *et al*, 1999).

Highest amount of dry matter was supplemented to sheep and goat during summer season might be due to less availability of grazing resources in summer season and availability of shrubs and three leaves to supplement in the ration. Similar supplementary feeding to goat was also recommended (Mahanta *et al*, 2002) to the goats grazing on range lands in Jhansi district. Our findings are in agreement that goat farming is predominant in semi-arid regions of the country including Bundelkhand (Ranjhan, 1997).

5.5 Economics of Milk Production

Economics of the milk production was worked out for cattle land buffaloes on the basis of present rates of input and output prevailing in the region.

The total input cost of rearing a milch cow was lower in FRG system (Rs. 6560/year) as compared to MF system (Rs. 10591/year). Similarly, the total income from sale of products was also lower in FRG system (Rs. 10125 /cow/year) than MF system (Rs. 14550/cow /year). But a narrow gap observed in net income from a cow under FRG (Rs. 3565/year) and MF system (3959/year) might be due to more labor requirement and limited investment on feed resources in MF system. However milk productivity of cows was higher in MF system (1252 litre/day) than FRF system (872 litre/day) might be due to better nutrient supply to cows in MF system. This indicates that FRG cows require feed supplementation to support their production potential.

The cost of rearing a buffalo was lower in FRG system (Rs. 10750/year) than MF system (Rs. 14739/year) in the region. The total income was also lower in FRG system (Rs. 17842/buffaloe/year) than MF system (23159 /buffalo/year) and net income from FRG and MF system was Rs. 8420 and 7092 /buffaloes/year. Similar to the cows, milk productivity of buffaloes was higher in MF system (1717 litre/buffaloe/year) than FRG system (1335 litre/year) due to feeding of required amount of nutrients (ICAR, 1985) in MF system.

The cost of milk production in FRG and MF system was Rs. 7.52 and 8.46 /litre for cows and Rs. 8.05 and 8.58/litre milk for buffaloes in the region. The lower productivity and less cost of milk production in FRG system were due to limited supply of concentrate and major part of feed supply through grazing resources. Paul *et al* (2001) also observed that grazing with limited supplementation was more economical than stall feeding.

Concentrate was the resource which had highest marginal value productivity in dairy animals and income could be increased by expenditure on feeding (Tripathi *et al*, 1986; Shalander *et al*, 1994; Deepak shah *et al*, 1995). Increase in investment also increases the annual return from dairy farms (Lee keejong *et al*, 1996).

The average expenditure on feed resources by the farmers was 57.9 and 56.7 percent of total rearing cost of cattle and buffaloes, respectively. The expenditure on feed may be 60-70 percent of total rearing cost of dairy animals. There is scope to increase the investment for feed cost especially on concentrates. Jansen *et al* (1997) suggested pasture improvement for livestock production and economic profitability.

Cost of rearing as well as total income from cows and buffaloes increased upwards with the size of land holding of owners in the region, might be due to feed resources availability and more investment capability. The net income from cows as well as buffaloes was higher in MF system. However, highest net income from lactating cow was in case of large farmers, while highest net income from buffaloes received by medium and large farmers might be due more investment on feed resources.

SUMMARY

Bundelkhand region is spread over 71618 km^2 area and bounded by the Yamuna in the north, ranges of Vindhyan Plateau in the south, the Sind in the northwest and Bhander ranges in the south-west. Undulating rugged topography, lack of underground water source, unfavorable climatic conditions especially high temperate and low & erratic rainfall and infertile soil are not very much conducive for agricultural development but having the possibility and potential of livestock based farming. To explore the possibility, the present study was designed with selected objectives mainly as to compare the Free Range Grazing (FRG) system verses Managed Feeding (MF) system and requirement, availability and quality of feed resources from all the available sources. Efforts have also been made to estimate the cost benefit balance sheet of livestock farming. The study is primarily based on intensive field survey, observations and personal interview with farmers through a set of questionnaire. For this purpose 10 villages from different parts of the region were

selected and from each village fifteen farmers from different categories were selected for the study. Animals under Free Range Grazing (FRG) system were allowed for grazing on crop harvested lands, wastelands or forest lands without any restriction during summer and part of the monsoon season. Such animals were fed limited amount of supplemental feed at home. The Managed Feeding (MF) system included stall-feeding, cut and carry system for rangeland grasses, rotational grazing and feeding fair amount of concentrates. Farmers adopted MF system for the lactating animals specially for milking buffaloes. The salient findings of this investigation may be summarized as follow:

The analysis of data related to feed resource availability and requirement showed that about 20 percent fodder was deficit in the sample villages. The major deficit was found from concentrate (- 44.9%) whereas in the case of roughage it was only 7.19 percent on dry matter basis. Large farmers possessed surplus amount of fodder roughage (+ 40%) and concentrate (+ 9.3%), whereas small farmers faced acute deficit of fodder roughage (- 37.6%) and concentrate (89.8%) for their livestock in the region. Crop residues were the major source of roughage supply and lowest amount of roughage received from cultivated fodder in the region.

The locally available feed resources as crop residues, cultivated fodder, concentrate and naturally grown grasses were evaluated for their nutritive values. The CP content in crop residues varied from 3.42 to 14.86 percent. The straws of cereal crops like wheat, paddy, barley and lentil contained the CP in the range of 3.42 to 4.37 percent. However the CP content was found higher in residues of leguminous crop

viz., moongbean straw (12.8%), chickpea straw (10.2%) and soyabean straw (14.8%). The anti-nutritional factor lignin content was ranged from 5.98 to 9.93 percent and IVDMD from 36.54 to 61.92 percent in different crop residues.

The main cultivated fodder crops were sorghum and maize in *kharif* and berseem and oat in *Rabi* season. The sorghum and maize fodder contained fair amount of CP 7.70 and 8.40 percent, respectively. Berseem was the rich source of CP (16.75%) and grown as major fodder crop by the dairy farmers. The oil cakes and cereal grains were the main concentrate available with the farmers. The high CP content was observed in oil cakes ranges from 26.8 to 39.1 percent. Cell wall fraction was lower in all the concentrates. IVDMD of concentrate were very high and ranged from 78.56 to 84.38 percent on DM basis. All the species of naturally grown grasses contained the CP in the range of 3.92 to 7.60 percent, minimum in *Chrysopogon fulvus* and maximum in *Cynodon dectylon*, respectively. The lignin content was in the range of 5.92 to 7.6 percent and IVDMD varied from 48 to 60 percent.

Shrubs and tree leaves possessed high CP throughout the year (9.65 to 18.75%). Season wise analyses showed that CP content was higher in monsoon and summer season and moderately decline in winter season in all the shrubs and tree species. NDF and ADF increased with the maturity of leave and varied with the season. All the shrub species invariably exhibited lower content of NDF and ADF in summer or monsoon, at the time of emergence of new leaves. The lignin (ADL) content in the leaves of all the shrubs species ranged from 4.8 to 14.5 percent, which was comparatively lower in monsoon and increased in the winter season with the

maturity of leaves. Similarly, IVDMD values of tree leaves were higher in monsoon than summer and lowest in winter season. The mean IVDMD of shrubs and tree leaves was varied from 43.68 to 71.90 percent. Higher cell wall fraction and lower IVDMD was observed in winter season, when leaves matured.

The annual average of dry matter intake (DMI) of milch cows was higher in MF system (6.81 kg/h/d) as compared to FRG system (5.70 kg/h/d), in the region. The feed intake was similar among animals of different landholders in FRG system, however in MF system large farmers fed their animals with higher amount of feed compared to small and medium landholders. Cows with large farmers received significantly higher green fodder as compared to small and medium landholders. In summer season green fodder was not available to the animal in FRG system and cows of small farmers in MF system. The intake of crop residues in MF system by the milch cows (4.83 kg) was significantly higher as compared to FRG system (3.96 kg) in summer season. The amount of concentrate fed through out the year by the dairy farmers to the lactating cows, was 1.48 and 1.07 kg/h/d in MF and FRG system, respectively. The study also revealed that large farmers supplied significantly higher amount of nutrients to milch cows as compared to medium and small farmers. Milch cows under MF system was fed round the year with higher DCP and TDN (0.354 and 4.116 kg/h/d) as compared to cows under FRG system (0.315 and 3.959) kg/h/d). However, cows under FRG system were faced deficit of 20.7% DCP and 14.7 %TDN as compared to standard requirement of ICAR, 1985. Acute nutrient deficit (46% DCP and 36% TDN) in FRG cows during summer season .

The year wise, dry matter intake of milch buffaloes was significantly higher (8.75 kg/h/d), in MF system as compared to FRG system (7.75 kg/h/d). In winter season DMI of buffaloes did not differ significantly in both the feeding systems (9.01 and 9.06kg/h/d). But large and medium categories of farmers offered significantly higher quantity of green fodder in MF system during winter season. The maximum dry fodder (6.24 kg/h/d) was offered to the buffaloes in MF system during summer season and lowest (4.43 kg/h/d) during monsoon by the farmers who have adopted FRG system. The DMI of milch buffaloes was observed significantly higher in MF system (8.39 kg/h/d) compared to FRG system (6.52 kg/h/d) during summer season. Large farmers of MF system fed their milch buffaloes higher amount of DM (9.11 kg) as compared to medium (8.43 kg) and small landholders (7.61 kg/h/d) in summer season. However DM intake was significantly lower during summer in buffaloes under FRG system in all the categories of farmers.

The concentrate feeding to milch buffaloes was higher in summer season due to remunerative price of milk. Buffaloes under MF system were fed higher amount of concentrate (2.18 kg/h/d) than FRG system (1.81 kg/h/d). The large and medium farmers fed significantly higher amount (2.55 and 2.30 kg/h/d) of concentrates as compared to small landholders (1.70 kg/h/d) in MF system. Medium and large farmers have taken care of buffaloes feeding, in all the season while only large farmers fed milch cows better in both the feeding systems.

The buffaloes under MF system received recommended level of DCP and TDN, even surplus amount of DCP (+ 5.90%) and TDN (+ 2.74%) in case of large

farmers. But the buffaloes under FRG system received deficit amount of DCP (-16.50%) and TDN (-11.99%). Maximum deficit of DCP and TDN was observed in summer season for the buffaloes under FRG system. In monsoon and summer season DCP and TDN supply to milch buffaloes were significantly (P >0.05) higher in MF system compared to FRG system.

The average milk yield of cows fed under MF system was 3.42 litre/day against 2.39 litre/day in FRG system. The milk yield of FRG cows in winter season was similar to cows in MF system (3.41 and 3.72 litre/day), whereas FRG cows were low producer for rest of the seasons. The cows of large farmers in MF system produced highest quantity of milk (3.87 litre/day) throughout the year, due to constant supply of DCP and TDN.

The average milk yield of buffaloes was also higher in MF system (4.66 litre/day). The highest milk yielded by the buffaloes of large farmers (5.94 litre/day) in MF system during winter and lowest in FRG buffaloes of small farmers (1.5 litre/day) during summer. Buffaloes of large and medium farmers in MF system yielded significantly higher quantity of milk (5.11 and 4.91 litre/day) as compared to buffaloes of small landholders (4.09 litre /day).

The mean dry matter intake of cattle heifers was 4.05 kg/h/d throughout the year. The DMI was highest in winter (4.57 kg) than monsoon (4.22 kg) and lowest in summer season (3.36 kg/h/d). In monsoon and summer season, the DMI of cattle and buffalo heifers was lower than standard feeding due to free range grazing by all the animals. Animals with small landholders received lowest DMI due to limited

supplementary feeding by their owners. The average DCP and TDN supply to growing cattle were 0.190 and 2.259 kg/h/day in the region, which was deficit by 35.5 and 13.3 percent, respectively compared to standard requirements however, acute deficit of DCP (-58.3%) was observed in summer season. Buffaloes were fed better than cow heifers in the region. The average DCP and TDN supply of growing buffaloes were deficit only 16.8 and 3.4 percent as composed to standard requirements. The maximum deficit of DCP and TDN was observed in summer season with all the categories of the farmers because most of the green fodder and concentrate available with the farmers were usually field to lactating animals.

The growth rate of cattle heifers was highest in winter season (231 g/day) than in monsoon (219 g/day) but in summer reason average growth was negative (-11 g/day). Cattle lost their body weight in small (-25 g/day) and medium categories of the farmers (-17 g/day) during summer season. The average growth of buffaloes heifers was similar in monsoon and winter season (314 g/day) whereas, lower growth rate of buffaloes observed in summer season (53 g/day). The growth rate of buffaloes for large and medium categories was 250 and 241 g/day, which was higher than buffaloes of small farmers (189 g/day). Highest live weight gain was recorded in the buffaloes of large farmers (342 g/day) in winter season and lowest in the heifers of small farmers (17 g/day) during summer season. The growth rate of buffalo heifers was better than cows in the region but lower than standard growth.

Feed intake of sheep and goat was recorded in different seasons for the animals of all categories of the farmers . The large farmers were not rearing sheep in the region

due to some social reasons. The average supplementary feeding to sheep was similar in small (0.50 kg DM/h/d) and medium (0.52 kg DM/h/d) landholders. However, medium categories of farmers supplemented moderately higher amount of concentrate to their sheep. The average dry matter supplemented to goat by small, medium and large farmers was 0.55, 0.54 and 0.60 kg/h/d, respectively. The concentrate was maximum supplemented to goat in summer season by large farmers (0.27 kg/h/d) and higher amount of crop residues was also supplemented in summer (0.41 kg/h/d) by all the categories of the farmers.

Economics of the milk production was worked out for cattle land buffaloes on the basis of present rates of input and output prevailing in the region. The total input cost of rearing a milch cow was lower in FRG system (Rs. 6560/year) as compared to MF system (Rs. 10591/year). Similarly, the total income from sale of products was also lower in FRG system (Rs. 10125 /cow/year) than MF system (Rs. 14550/cow /year). But the net income from a cow under FRG and MF system was Rs. 3565 and 3959/year, respectively. However milk productivity of cows was higher in MF system (1252 litre/day) than FRF system (872 litre/day). This indicates that FRG cows requires feed supplementation to support their production potential.

The cost of rearing a buffalo was lower in FRG system (Rs. 10750/year) than MF system (Rs. 14739/year) in the region. The total income was also lower in FRG system (Rs. 17842/buffaloe/year) than MF system (23159 /buffalo/year) and net income from FRG and MF system was Rs. 8420 and 7092 /buffaloes/year. Similar to the cows, milk productivity of buffaloes was higher in MF system (1717

litre/buffaloe/year) than FRG system (1335 litre/buffalo/year) due to feeding of required amount of nutrients in MF system. The cost of milk production in FRG and MF system was Rs. 7.52 and 8.46 /litre for cows and Rs. 8.05 and 8.58/litre milk for buffaloes in the region.

Buffaloes were better maintained in MF system by large as well as medium farmers, while cows by large farmers only. The cattle and buffalo heifers were maintained in managed feeding system during winter season and in free range grazing during summer and part of monsoon season by all categories of the farmers. Buffaloes were fed better than cow heifers in the region. The milk productivity and net income from cows as well as buffaloes was higher in MF system.

Conclusion

The Region is facing deficit of feed resources mainly green fodder and concentrate. Feed intake, nutrient supply and milk production of lactating cattle and buffaloes were lower in FRG system. The acute deficit of nutrient and poor growth of heifers observed during summer season. Milk productivity and net income from cattle and buffaloes were higher in MF system. Milk production and net income increased with the increase in the investment by the farmers in both the feeding systems. Production potential of the animals have not been fully utilized in FRG system. There is an urgent need to supplement the nutrients through green fodder, concentrate and crop residues to support their production potential.

➢ **Enrichment of poor quality crop residues**

The crop residues may be treated with urea for enhancing its nutritional quality and palatability. Such value addition of crop residues will be appropriate technique for the small landholders because they have no option for green fodder cultivation. Conservation of surplus green fodder as silage or good quality hay may provide nutrients to livestock during summer season.

➢ **Development of food /fodder crop farming system**

Farmers have limited irrigation facilities in the region, and they utilize their irrigation resources for food crops. Technology of inter-cropping of food and fodder crops is required, without affecting the yield of main crops. The dual purpose food /fodder varieties may also be introduced in the region to increase the fodder availability. Economic viability of fodder crops need to be examined at village level through on farm trials.

- **Soil- water conservation and Irrigation facilities**

The increase in irrigation facilities through micro watershed development, check dams, bunding and other water conservation measures may positively affect the production of crop as well as fodder in the region. That will also enhance the economic conditions of the farmer and investment capacity for the livestock in the region.

- **Grassland management, Agroforestry and Silvipasture**

The high pressure of livestock population on the grazing land resulted in decline in the production and availability of natural grassland, wastelands and forest. The potential of these grazing land to provide the required feed is further limited by the short monsoon period in the region. Proper management of these natural grasslands, wasteland is essentially required through participation of farmers of the region. Techniques of agroforestry and silvipasture may be the good option that will provide fuel as well as fodder through cut and carry system.

- **Marketing infrastructure for fodder and livestock products**

There is no proper marketing infrastructure for sale of surplus fodder, milk, and other livestock products in the region. Farmers are not aware about recent processing technique of milk and other dairy products. A lot of middleman involved in the marketing of milk from village to consumers in cities and getting major share from consumer price. The region has full potential of livestock development. Establishment of Gujrat pattern dairy cooperatives may provide the infrastructure for marketing and

processing of milk. The producers will get better price of their products and it will stimulate dairy activities in the region.

- **Increase the number of improved bulls**

Efforts were made earlier also on breed up-gradation in the region. But, most of the cows were covered by local bulls during free range grazing in summer season. The cumulative efforts on controlling the free range grazing and increasing the number of graded bulls in each village may be the option for breed improvement.

- **Conversion of FRG to managed feeding system**

The region suffers from a shortage of livestock feed for most of the year. In the village where stall feeding practices are mainly followed, the resource poor farmers may still dependent on free rage grazing, as they can not afford to purchase the feeds for stall feeding. Even, within the heard held by a farmer, the cattle might be allowed for free grazing while buffaloes are stall fed. These factors are dependent on availability of feed resources to the individual farmer. This practices of free range grazing has additional social consequence as it discourage farmers from growing crop in the summer. Most of the suggestions given are directly or indirectly related to increase the feed resources in the region. Active participation of farmers required to convert the system from free range grazing to stall feeding with controlled grazing or managed feeding system.

BIBLIOGRAPHY

Albrecht, K.A. and Broderick, G.A. (1990) Degradation of forage legume protein by rumen microorganisms. In: Agronomy abstracts. American Society of Agronomy. Madison, WI, p. 185.

AOAC (1990) Official methods of analysis. 15th Edn. Association of Official Agricultural Chemists Washington, DC.

Badal, P.S. and Dhaka, J.P.(1998) An analysis of feeding pattern and cost of milk production in Gopalganj district of Bihar. *Indian J.Dairy Sci.*, 51: 121-125.

Buxton, D.R. and Fales, S.L. (1994) Plant environment and quality. Forage Quality, Evaluation and Utilization. American Society of Agronomy. Madison, WI, pp. 200-228.

Deepak Shah, Parmatma Singh, Shah, D. and Singh, P. (1995) Resources productivity and resource use efficiency of milk production in Bulandshahar district of Uttar Pradesh. *Indian J. Anim. Sci.*, 65: 921-929.

Deoghare, P. R. (1997) Sustainability of on farm income and employment through livestock production in Mathura district of Uttar Pradesh. *Indian J. Anim. Sci.*, 67: 916-919.

Desai, H. B., Desai, M. C., Patel, D. C., Patel, G. R. and Shukla, P. C. (1988) A study of animal feed resources and feeding practices of dairy animals in Valsad district. *Gujrat Agricultural University Research Journal*. 13: 58-64.

Dzowela, B.H., Hove, L., Topps, J.H. and Mafongoya, P.L. (1995) Nutritional and anti-nutritional characters and rumen degradability of dry matter and nitrogen for some multipurpose tree species with potential for agroforestry in Zimbabwe. *Anim. Feed Sci. & Technol.*, 55: 207-214.

Goering, H. K. and Van Soet, P. J. (1970) Forage Fibre Analysis. Agricultural Handbook No. 379. A R, USDA, Washington D C.

Gomez, N., Kombiok, James; Rajitha, P., Soam, Sudhir; Williams, Stemphen; Yahya, Mshana (1998) Towards sustainable livestock management. ICRA Working Document Series 69, IGFARI, Jhansi.

Government of India (1991) Statistical Bulletin-1991. Office of the Deputy Director, Directorate of Economics and Statistics, Jhansi Division, Jhansi, U P, India.

Hampaiah, R. (1981) Improved forage forestry systems for semi-arid regions of India with special reference to Bundelkhand region. *Indian Journal of Range Management*. 2: 109-117.

Handa, M.C. and Gill, R.S. (1989) Nutritional status of dairy animals kept by different categories of farmers in Punjab. *Indian J. Anim. Nutr.*, 6: 38-43.

ICAR (1985) Nutrients requirements of livestock and poultry. Indian council of Agricultural Research , New Delhi.

IGFRI (1992) Integrated development of wastelands in Bundelkhand region- bench mark survey and basic resource report. IGFRI , Jhansi.-284003,India.

Jansen H, Nieuwenhuyse, A. Ibrahim, M., Abarca, S. and jansen, H. G. P. (1997) Economic evaluation of the incorporation of legume into improved pastures compared with traditional cattle feeding system in the Atlantic Zone of Costa Rica. *Agroforesteria en las Americas*. 4: 9-13.

Lal, D., Gupta, R., Dixit, V.B. and Sethi, R.K (1995) Nutritional status of lactating buffaloes in Hisar- a random survey anlaysis. *Indian J. Dairy Sci.*, 48: 378-381.

Lapierre, C. (1993) Application of new methods for investigation of lignin structure. Forage Cell Wall Structure and Digestibility. ASA-CSSA-SSSA, Madison, WI, pp. 136-166.

Lee Keejong, Ki KwangSeok, Kim YoungJin, Lee K.J., Ki, K.S. and Kim, Y. J. (1996) Study on the expansion of dairy farms managed by family labour. *RDA Journal of Agricultural Sciences, Farm Management, Agricultural Engineering , Sericulture and Farm Product Utilisation,* 38: 884-893.

Mahanta, S.K., Pailan, G.H. and Verma, N.C. (2002) Influence of concentrate supplementation on performance of goats on rangeland: an on farm study. *Anim. Nutr. & Feed Tech.*, 2 : 161-167.

Maity, S.B., Kundu, S.S. and Anil Kumar (2000) Insecure breed of livestock in Bundlekhand. *Flora and Fauna*, 6: 89-90.

Majumdar, A.B., Debroy, R., Rakib, A. (1989) Seasonal effects on nutritive quality of fodder tree leaves. Proceeding of IUFRO, International Workshop in Agroforestry for Rural Needs. Vol. II, New Delhi. pp. 182-185.

Misra, A.K. and Dwivedi, P.N. (1997) Bundelkhand men bakri palan ki sambhavnayen: ak adhyayan. Rastriya Sangosthi on Chara Anusandhan avam Pashudhan Vikas ke Naye Ayam (*Hindi*). 20-22 Dec. 1997, IGFRI, Jhansi.

Mudgal, V.D., Pradhan, K. and Devendra, C. (1988) Animal feed resources and current pattern of utilisation in India. Non conventional feed resources and fibrous agricultural residues: strategies for expanded utilization. Proceedings of a Consultation held in Hisar, India, 21-29 March, 1988. 139-146.

Negi, A.S., Bhadoria, B.K., Nag, S.K. and Kundu, S.S. (2003) Chemical composition of some browse species of Bundelkhand. *Animal Nutrition and Feed Technology*. 3: 53-59.

NRC (1988) Nutrient Requirements of Domestic Animals, 6th Edn. National Academy of Science, National Research Council, Washington DC.

Pachauri, V. C., Mahanta, S. K., Singh, S., Pailan, G. H., Verma, N. C. and Ranjitha, P. (1999) Socio-economic impact of improved feeding management of goat production. Proceeding of the Final Workshop on Indo-UK Forage Production Project, October 7-8, 1999. IGFRI, Jhansi, India.

Pandey, U. K., Sigh, J.P. and Suhag, K.S. (1980) Milk production function for Bundelkhand region of Uttar Pradesh. *Indian J. Dairy Sci.*, 33: 99-109.

Patange, D. D., Kulkarni, A.N., Gujar, B.V. and Kalyankar, S.D.(2002) Nutrient availability to milch Marathwadi buffaloes in their home tract. *Indian J. Anim. Nutr.*, 19: 41-46.

Pathak, N.N. (1988) Feeding standards for buffalo. IVRI, Izatnagar, India

Paul, S.S., Kamboj, M.L. and Chawla, D.S. (2001) Growth performance and economics of rearing nili-ravi buffalo male calves on different feeding regimes. *Indian J. Anim. Nutr.*, 18 : 43-48.

Pradhan, K. (1994) Poor quality feeds for cattle and buffaloes. Proc. Summer Institute on Recent Advances in Animal Nutrition. Animal Nutrition Division, IVRI, Izatnagar. India.

Punj, M. L. and Devendra, C. (1988) Availability and utilisation of non conventional feed resources and their utilisation by ruminants in South Asia. Non conventional feed resources and fibrous agricultural residues: strategies for expanded utilisation. Proceedings of a Consultation held in Hisar, India, 21-29 March, 1988. p 50-61.

Rai, B., Ram, G. and Prasad, D. (1993) Goat production system in two adopted villages of Mathura district, Uttar Pradesh. *Livestock Advisor*. 18: 19-21.

Ramana, D.B.V., Sultan Singh and Solanki, K.R. (2002) Nutritive value of some tree and shrub species. *Indian J. Anim. Nutr.* 19 : 262-265.

Ramana, D.B.V., Sultan Singh, Solanki, K.R. and Negi, A.S. (2000) Nutritive evaluation of some nitrogen and non-nitrogen fixing multipurpose tree species. *Animal feed Science and Technology*, 88: 103-111.

Ramana, J V; Prasad,C S and Gowda, S K. (2000). Mineral profile of soil, feeds, fodders and blood plasma in southern transition zone of Karnataka. *Indian J. Anim. Nutr.*, 17: 179-183.

Ranjhan, S K (1999) Feeding management strategies. *Indian Dairyman*, 51: 13-18.

Ranjhan, S.K. (1997). Problems and prospective of animal nutrition resource in India in twenty first century. Platinum jubilee celebration of animal nutrition research at IVRI. Publication and Information Section, IVRI, Izatnagar, India . pp- 21-36.

Ravindran V and Devendra C. (1988) Feed availability, requirements for animals and current patterns of utilisation in Sri Lanka. Non conventional feed resources and fibrous agricultural residues: strategies for expanded utilisation. Proceedings of a Consultation held in Hisar, India, 21-29 March, 1988. 171-180.

Roggero P P, Bellon S, Rosales M, Molenat G, Chenost M, Hubert D and Gouy J. (1995) Sustainable feeding systems based on the use of local resources. Satellite Symposiums of the IV th International Symposium on the Nutrition of Herbivores. Use of forage resources by ruminants in warm climate countries, Montpellier, France, 7-9 September 1995. *Annales de zootechnie*. 45: 105-118.

Sajjan Sihag, Yadav K.R., Khirwar, S.S. Rajesh and Heera Lal. (2002) Availability of feeds and feeding practices and socio-economic status of farmers in irrigated cotton based system. *Indian J. Anim. Nutr.*, 19 : 256-261.

Saran, Sandeep; Singh, R.A., Singh, Rajbir; Rani, Isabella and Singh, K.K., (2000). Feed resources for rearing livestock in the Bundelkhand region of Uttar Pradesh. *Ind. J. Ani. Sci*,. 70: 526-539.

Sen, K.C. and Ray, S.N. (1971) Nutritive values of Indian feeds and feeding of animals. 6th Ed. ICAR, New Delhi.

Shalander, Kumar; Agrawal, S. B., and Kumar, S. (1994) Resource use efficiency of milk production in Mathura district of Uttar Pradesh. Indian J. Dairy Sci. , 47: 915-920.

Sharma, V.P. and Singh, Raj Vir. (1993) Resource productivity and allocation efficiency in milk production in Himachal Pradesh. *Indian J. of Agric. Economics*: 48: 200-15.

Singh, A. K., Upadhyay, V. S., Misra, A. K. and Sigh, K. K. (1998) Ruminal dry matter, organic matter and nitrogen degradability of common tree leaves of Bundelkhand region. *Range Management and Agroforestry*. 19: 203-205.

Singh, A. K., Upadhyay, V. S., Misra, A. K. and Sigh, K. K. (1999) Seasonal variation in chemical composition of important tree leaves of Bundelkhand region. *Indian J. Anim. Nutr.*, 16: 269-271.

Singh, A.K., Vidyarthi, V. K., Verma, D.N. and Lal, S.N. (1998) Nutritional status of buffaloes in rural areas of Azamgarh district of Uttar Pradesh. *Indian J. Anim. Nutr*. 15: 126-128.

Singh, J.P., Dwivedi, P.N. and Ekka, N.S. (2001). Application of remote sensing and GIS techniques in assessing forest cover and impact of forest grazing. *Indian Cartographer*. 21: 27-30

Singh, J.P., Dwivedi, P.N., Ekka ,N.S. and Tripathi, B. (2001) Inventory and mapping of grazing lands using IRS data and GIS for developmental planning of forage and livestock production. *Indian Cartographer*. 21 : 9-14.

Singh, U. N., Anoop Srivastva and Srivastva, A. (1995) Forage production and nutritive value of Bothriochloa grassland community in Bundelkhand region, India. *Range Management and Agroforestry*, 16: 25-37.

Skarpe, C. and Bergstrom, R. (1986) Nutrient content and digestibility of forage plants in relation to plant phenology and rain fall in the Kalahari, Botswana. *J. Arid Environ*, 11: 147-164.

Snedecor, G. W. and Cochran, W. G. (1967) Statistical Methods, 6th ed. Oxford and IBH Publishing Co., New Delhi, India.

Spicer, H. M. and Goonnewardene, L. A. (1994) Alberta dairy farm survey response. *Journal of Dairy Science*, 77: 3460-72.

Thomas, C.K. and Shasty, N.S.R.(1991) Dairy Bobine Production. Kalyani Publishers. New Delhi. P: 572-573.

Tripathi, A.K. (1991) Availability of nutritional resources in the eastern region and their effective utilisation to benefit dairy farmers. *Indian Dairyman*, 43: 554-561.

Tripathi, R. S., Garg, J. S. and Singh, G. N. (1986) An economic analysis of dairy enterprise in Bundelkhand region of Uttar Pradesh. *Indian Journal of Dairy Science*. 39: 17-23.

Tyagi, R. K. (1997) Atlas of forage and legumes of Bundelkhand.. IGFRI, Jhansi.

Udeybir, Mandal, A.B. and Yadav, P.S. (2000) Comparative dry matter intake and nutrient utilization efficiency in growing cattle and buffaloes -an analysis of observed results. *Indian J. Anim. Nutr*. 17 : 56-63.

Van Soet,P. J., Wine, R. H. and Moore, L. A. (1966). Estimation of the true digestibility of forage by the invtro digestion of cell wall. Proc. X Int. Grassland Congr. Helsinki, Finland. pp 438.

Yadav, P.S., Mandal, A.B. and Dahia, D.V. (2002). Feeding pattern and mineral status of buffaloes in Panipat district of Haryana State. *Anim. Nutr. and Feed Tech*, 2 : 127-138.

ANNEXURE

Annexure 1 Requirement and availability balance sheet of feed resources (DM t/year)

Particulars	Categories of farmers			
	Small	Medium	Large	Total
Number of households	50	50	50	150
Number of ACU	304	367	339	1010
Requirements				
Fodder roughage DM	543.70	656.38	606.30	1806.39
Concentrate DM	233.02	281.31	259.84	774.17
Total DM requirement (t/year)	776.72	937.69	866.15	2580.55
Available feed resources				
Roughage (DM t/year)				
Crop residue	192.30	427.90	817.20	1437.40
Cultivated fodder	0.00	9.20	14.10	23.30
Barren/waste land fodder	15.40	8.60	11.60	20.60
Grazing in forest/community land	131.70	56.20	7.30	195.20
DM from roughage	339.40	501.90	850.20	1676.50
DM from Concentrates	23.80	79.20	284.20	387.20
Available total DM	363.20	581.10	1134.40	2063.70
Balance sheet				
Fodder roughage DM (t/year)	-204.30	-154.48	243.90	-129.89
Concentrate DM	-209.22	-202.11	24.36	-386.97
Total DM (surplus/deficit)	-413.52	-356.59	268.26	-516.85
Percent surplus/deficit				
Fodder roughage DM %	-37.58	-23.54	40.23	-7.19
Concentrate DM %	-89.79	-71.85	9.37	-49.98
Total DM (surplus/deficit) %	-53.24	-38.03	30.97	-20.03

Annexure 2 Feed intake of livestock from grazing and uncultivated fodder (kg/d, fresh basis)

Seasons	Particular	Free range grazing (*Anna Pratha*)				Managed feeding system			
		Small	Medium	Large	Average	Small	Medium	Large	Average
Milking cows									
Monsoon	Green fodder	5.90	5.25	5.17	5.44	5.70	4.01	3.88	4.53
	Dry fodder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter	Green fodder	4.03	3.22	3.05	3.43	3.96	3.19	3.05	3.40
	Dry fodder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Summer	Green fodder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Dry fodder	1.80	1.80	1.80	1.80	0.00	0.00	0.00	0.00
Milking buffaloes									
Monsoon	Green fodder	6.90	5.28	4.40	5.53	5.98	5.19	4.45	5.21
	Dry fodder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winter	Green fodder	4.15	3.77	2.25	3.39	4.20	3.86	2.30	3.45
	Dry fodder	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Summer	Green fodder	0.00	0.00	0.91	0.30	0.00	0.00	0.00	0.00
	Dry fodder	2.23	2.23	2.23	2.23	0.00	0.00	0.00	0.00

Annexure 3 Feed intake of livestock from crop residue and cultivated fodders (kg/d, fresh basis)

Season	Particular	Free range grazing (*Anna Pratha*)				Managed feeding system			
		Small	Medium	Large	Average	Small	Medium	Large	Average
Milking cows									
Monsoon	Green fodder	0.87	1.45	1.58	1.30	1.40	2.30	2.37	2.02
	Dry fodder	3.45	3.38	3.41	3.41	4.78	4.80	4.80	4.79
Winter	Green fodder	0.85	2.04	2.93	1.94	0.99	2.11	3.00	2.03
	Dry fodder	4.96	4.80	4.75	4.84	4.94	4.87	4.80	4.87
Summer	Green fodder	0.00	0.00	0.00	0.00	0.00	1.06	1.52	0.86
	Dry fodder	2.06	2.18	2.25	2.16	4.67	4.70	5.12	4.83
Milking buffaloes									
Monsoon	Green fodder	1.39	2.78	3.41	2.53	2.23	2.83	3.45	2.84
	Dry fodder	4.20	4.35	4.75	4.43	5.35	5.50	5.51	5.45
Winter	Green fodder	2.00	4.03	6.00	4.01	2.00	3.98	6.00	3.99
	Dry fodder	6.20	6.09	6.02	6.10	6.25	6.15	6.00	6.13
Summer	Green fodder	0.00	0.00	0.00	0.00	0.00	1.83	2.72	1.52
	Dry fodder	2.87	3.26	3.40	3.18	6.35	6.20	6.18	6.24

Annexure 4 Growth in body weight (g/day) of cattle and buffaloes heifers

Seasons	Months	Cattle heifers				Buffalo heifers			
		Small	Medium	Large	Average	Small	Medium	Large	Average
Monsoon	July	100	100	100	100	133	167	200	167
	Aug	200	200	200	200	367	433	433	411
	Sept	367	333	367	356	333	400	400	378
	Oct	200	233	233	222	300	300	300	300
	Average	217	217	225	219	283	325	333	314
Winter	Nov	133	167	200	167	167	167	167	167
	Dec	167	167	233	189	300	367	367	344
	Jan	233	267	300	267	300	467	467	411
	Feb	300	267	333	300	300	333	367	333
	Average	208	217	267	231	267	333	342	314
Summer	March	233	233	267	244	233	267	267	256
	April	67	100	100	89	167	167	200	178
	May	-133	-133	-100	-122	-133	-100	-100	-111
	June	-267	-267	-233	-256	-200	-67	-67	-111
	Average	-25	-17	8	-11	17	67	75	53